OPERATIVE DENTISTRY

C. N. JOHNSON

A TEXT-BOOK
OF
OPERATIVE DENTISTRY

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A TEXT-BOOK OF

OPERATIVE DENTISTRY

BY VARIOUS AUTHORS

EDITED BY

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PREFACE TO THE FOURTH EDITION

Much new material is introduced in the fourth edition of this work. Owing to the death of four of the original contributors, Drs. Geo. W. Cook, Ferdinand J. S. Gorgas, George Edwin Hunt, and Garrett Newkirk, it has been necessary to enlist the coöperation of four new writers, and the editor takes great pleasure in announcing that these chapters are contributed by such noted men as Drs. Lewis E. Ford, Frederic R. Henshaw, John A. Marshall, and P. G. Puterbaugh.

To secure the services of writers of this type is to add an element of strength to the book, and to inspire confidence on the part of the readers. The work is therefore sent out with considerable satisfaction, and with the hope that it will receive the same hearty support accorded to previous editions. If this hope is realized, it is all that any publisher or author could wish for.

C. N. J.

CHICAGO, 1923.

PREFACE TO FIRST EDITION

In preparing this book for the profession the aim has been to condense the latest thought on the various subjects into the closest possible limit consistent with a clear elucidation of the ideas presented. It has been the constant effort to bring the work strictly up to date, and with the rapid evolution of dental thought in progress at the present time this has been no small task. As an illustration it is only necessary to mention the circumstance that one entire chapter—that by Dr. Nyman on the gold inlay—was wholly rewritten after it was in type and the illustrations made for it. The original article was discarded as being out of date the moment the cast method became a demonstrated fact. This is only indicative of the great care taken by the various authors in the revision of their work, and for which the editor wishes at this time to express his great appreciation.

Particular attention is called to the illustrative character of the work. Most of the cuts were made specially for the book, and many of them are striking in their originality. Those, for instance, illustrating Dr. Turner's chapter on "The Anatomy of the Human Teeth" were made from photographs of natural teeth, a typical specimen of each tooth being selected for this purpose and photographed on its different surfaces. The effect has been to present something perfectly true to nature.

Mention might be made of distinguishing features in each chapter in the book, but this would appear unnecessary with the work in the reader's hands. It seems appropriate, however, to call attention to Dr. Pullen's chapter on "Orthodontia" which we believe is one of the most concise and practical presentations of this important subject that has yet appeared.

To the contributors the editor feels under deep obligation for their cordial coöperation in preparing the work, and to the publishers for their uniform courtesy and painstaking care in every detail of publication.

C. N. J.

Chicago.

CONTENTS

INTRODUCTION

Operative Dentistry may be defined as the science and art which aims at the preservation of the natural teeth in a state of health and beauty. Its highest office is to prevent disease or deformity, but where either of these has already occurred it is then its function to remedy the evil, and check its further progress. The dentist who does the best for his patient is the one who, in addition to the development of the highest manipulative skill, studies most carefully the conditions surrounding the field of his operations. To fill a cavity in a tooth in the most perfect manner possible, when the surrounding tissues are in an abnormal condition, without a recognition of this fact and the most careful attention to the abnormality, is far from good practice. To attempt to remedy any disorder in the mouth by confining attention solely to the immediate seat of the trouble is frequently to court failure. The human economy is so complicated that cause and effect are often remote from each other, and the practitioner who does the best service to his patient is the one who in addition to being an acute observer extends his observation over the widest field.

The conscientious dentist, when he finds himself baffled in discovering the cause or relieving the symptoms of any affection of the mouth will not hesitate to call in consultation a specialist in dentistry or medicine as the case indicates, and particularly is it desirable in instances of peculiar idiosyncrasies to consult with the family physician of the patient.

No individual practicing a profession like dentistry should think lightly of his obligations, and no practitioner can properly fulfill his obligations without developing the habit of painstaking care in all his work whether of diagnosis or treatment. It should early be recognized by the young practitioner that dentistry demands of those who aim to excel in its practice a more diversified order of talent than any other calling. To be a good dentist an individual should develop the scientist's attitude toward the intimate and sometimes intricate relationship between cause and effect, he should be a close observer of phenomena, a mechanician of the first order, an artist with the sense of harmony highly cultivated, a physician in his diagnosis of disease, haumanitarian in his ministrations to others, and above all a cultured gentleman of the highest mental and moral fiber.

This does not imply that in the beginning he must be endowed with great brain capacity or natural attributes of an unusual character. The encouraging thing about dentistry is that most of the qualities necessary for achievement are capable of cultivation, and the man who will apply himself with sufficient zeal and perseverance is certain of at least a reasonable measure of success. The chief requisite is the patience to plod.

If every dentist would bring to his work a real sincerity of purpose to serve his patients to the highest possibilities of his art, the future of the profession would be secure. There would be less need than there is today of artificial teeth, and the full functional use of the natural organs in mastication and in harmony of expression would be more generally recognized and appreciated. As we develop dentistry along the lines of prevention and conservation we shall bring it nearer and nearer to its highest mission. To do the greatest good to the largest number, to do this good without thought of self advancement, to work for the love of it and for the benefit it brings to humanity—this is the acme of faithful service and the only kind of effort which will bring permanent satisfaction. Unless a dentist is willing to do this he will fall short of all that his profession has to offer him, if he does it he may be certain of an encouraging measure of attainment.

But to accomplish anything of note he must be progressive. The methods of yesterday will not suffice for today. No profession is developing more rapidly than dentistry and he who would give the best service must ever be alive to the latest advances. The foremost thinkers of the profession are constantly placing their ideas before their fellow practitioners, and the man who keeps abreast must be alert to avail himself of the results of their matured thought. It is with the purpose of presenting this thought in the most condensed form as it relates to the different departments of operative dentistry that the present volume is issued.

OPERATIVE DENTISTRY

CHAPTER I

THE ANATOMY OF THE HUMAN TEETH

BY CHARLES R. TURNER, D. D. S., M. D.

The teeth of man are hard masses of calcified tissue attached to the mandible and maxilla and having as their chief function participation in the work of his masticatory apparatus. His food, as introduced into the mouth, the beginning of the digestive tract, consists of articles of various degrees of physical consistency. In order that this may be prepared for subsequent stages in the digestive process, much of it must be mechanically subdivided into particles of convenient size to go through the alimentary canal and be acted upon by the digestive ferments and solvents. Such subdivision is performed in the mouth by the act of mastication and it is with this function that the teeth are chiefly concerned. They afford hard opposed surfaces which are brought into contact in the approximation of the jaws by the muscular apparatus and by this means the food is cut or crushed into particles of the desired size.

The teeth also have a functional relationship with the apparatus by which voice and speech are produced and bear a cosmetic relation to the features of the face.

The adult human denture consists normally of thirty-two teeth which are divided in number equally between the upper and the lower jaw. These are known as the permanent teeth, in contra-distinction to the temporary or deciduous teeth which serve for purposes of mastication during the earlier years of life and are subsequently exfoliated to give place to their permanent successors.

The permanent teeth are divided anatomically into classes and these divisions largely correspond with their functions as portions of the masticatory apparatus. Thus, there are eight incisors, which serve in the incising of the food; four cuspids, whose chief function in the carnivorous animals is to pierce and hold the food, a function wholly rudimentary with

NOTE.—The author desires to acknowledge his indebtedness for Figs. 1 to 84 inclusive to Dr. George J. Paynter, of the Department of Dentistry, University of Pennsylvania, who selected and dissected the specimens, and to the Department of Dentistry, University of Pennsylvania, for whom the photographs were made, for permission to reproduce them.

man; eight bicuspids, which are intermediate in position and function between the cuspids and the molars, and lastly twelve molars which are the crushing and grinding teeth proper. The formula for the permanent human dentition is expressed:

$$I\,\frac{2-2}{2-2},\quad C\,\frac{1-1}{1-1},\quad B\,\frac{2-2}{2-2},\quad M\,\frac{3-3}{3-3} = 32$$

The deciduous denture consists of twenty teeth—eight incisors, four cuspids and eight molars.

As all the teeth possess certain characteristics in common it will be well to refer to these before undertaking a description of the individual teeth.

The *crown* of a tooth is that portion which projects beyond the gum margin and is normally covered with enamel. The *root* or *roots* of the tooth are imbedded in the alveolar process and are attached thereto by a fibrous membrane, the pericementum. The root and crown of a tooth unite at its *neck*, a point which corresponds to the point of juncture of the enamel and the cementum. This is also called the *cervix* and also the *gingival margin* of the crown. The sharpened extremity of a root is known as its *apex*, and this is the seat of an opening which transmits the nerves and blood vessels of the pulp of the tooth and is known as the *apical foramen*. The surface of a tooth which comes into contact with the corresponding surface of teeth in the opposing jaw is referred to as the *occlusal* surface. This term is also applied to the analogous portion of the incisor teeth although strictly speaking it should only apply to that of the lower incisors, inasmuch as this edge of the incisors of the upper jaw does not touch the teeth of the lower jaw, when the teeth are in occlusal contact, but normally is only brought into this relationship when the mandible is protruded. This is also referred to as the *incisive edge* of the incisors. Molar and bicuspid teeth have large tubercles upon their occlusal surfaces and these are known as *cusps*. The adjoining surfaces of teeth are known as their *proximal* surfaces, the most prominent point of which is called the *angle of the tooth*. If a vertical plane is passed between the central incisors of both jaws, those proximal surfaces of the teeth which are directed toward this are known as *mesial* surfaces, while those proximal surfaces directed away from it are known as *distal* surfaces. The surfaces of the six anterior teeth of each series which are in relation with the lips are called *labial*, while the corresponding surfaces of the remaining teeth which are in relation with the cheeks are called *buccal* surfaces. Those surfaces of the teeth which are directed inward toward the cavity of the mouth are known as their *lingual* surfaces.

The surface-form and internal anatomy of the permanent teeth will now be given in detail.

THE UPPER CENTRAL INCISOR

The crown of this tooth is wedge-shaped; the base of the wedge is at its cervical margin from which the broad labial and lingual surfaces converge to a straight cutting edge.

The Labial Surface (Fig. 1).—Irregularly quadrilateral in shape, this surface has four margins. The incisive edge which forms its lower margin

FIG. 1.—Left Upper Central Incisor. Labial Surface.

FIG. 2.—Left Upper Central Incisor. Lingual Surface.

is nearly straight; it is marked in the newly erupted tooth by two developmental grooves which disappear early in life because of the wearing down of the three tubercules which are found on this edge. The mesial margin is nearly straight or may be a long curve; the cervical border is convex rootward, while the distal margin is more convex than the mesial and is a little shorter. The surface itself is convex from the cervix to the incisive edge, the lower portion of it being, however, nearly flat, while that portion near the cervix is more curved and is marked by a *cervical ridge*. This face of the crown is convex from side to side and is marked by two longitudinal grooves which correspond to the lines of union of the three developmental lobes of the crown.

The Lingual Surface (Fig. 2).—This is irregularly triangular, the mesial and distal margins uniting with the cervical to form a rounded apex, while the base of the triangle is formed by the incisive margin. The mesial and distal margins are marked by rounded ridges of enamel which extend from the angles of the crown in a graceful curve rootward to unite with the *cervical ridge.* The mesial is slightly the longer of these two. The cervical is more pronounced than the other marginal ridges. It is sometimes cut

FIG. 3.—Left Upper Central Incisor. Mesial Surface.

FIG. 4.—Left Upper Central Incisor. Distal Surface.

near its center by a fissure and sometimes it is the seat of a rounded elevation of enamel; the *cingulum.* The lingual surface is concave inciso-gingivally and mesio-distally. Its center is occupied by a pronounced fossa, the *lingual fossa*, which is traversed by two longitudinal grooves. Occasionally a *lingual pit* is present and this occupies a position at the juncture of the cervical ridge and the lingual fossa.

The Mesial Surface (Fig. 3).—Being shaped like a spear-head or irregularly triangular in outline, this surface has three margins. The labial presents a long curve ending in the mesial angle of the tooth and is shorter than the lingual which it meets at this point. Both are bowed in a labial direction and the labial margin is the more pronounced, the lingual being rounded and marking less distinctly the boundary of the surface.

The cervical margin is concave in an incisal direction and at its terminations unites with both the labial and lingual borders at an acute angle. Near the incisive edge the surface is convex but this convexity decreases as the root is approached and the surface becomes either a plane or is marked by a slight depression at the gingival margin. The most prominent point of the surface is located one-third the distance from the mesial angle and this establishes the point of contact with the central incisor of the opposite side.

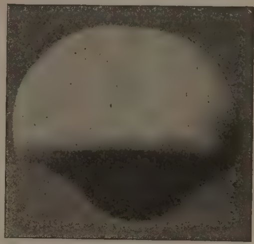


Fig. 5.—Left Upper Central Incisor. Incisal View.

The Distal Surface (Fig. 4).—While this is of the same general shape as the mesial surface, it is slightly smaller because of the location of the distal angle nearer to the cervix. Its margins are less distinct and the surface is more rounded and the point of contact with the lateral incisor is relatively nearer the cervix.

Fig. 6.—Left Upper Central Incisor. Longitudinal section cut labio-lingually showing pulp cavity.

The Incisive Edge (Fig. 5).—The incisive edge is formed by the intersection of the planes of the labial and lingual surfaces of the crown. These do not meet at an acute angle but their line of intersection is somewhat rounded. This edge extends from the *mesial* to the *distal angle*, usually almost in a straight line. In young subjects it is marked by the developmental grooves, but these usually disappear from the wearing of the surfaces. When the crown is viewed from below, the line of the incisive edge is occasionally bowed in a labial direction.

The Cervical Margin.—Beginning at the mesio-labial portion of this line, it extends with an upward curve upon the labial surface, downward on the distal, upward on the lingual, and downward again on the mesial to the point of beginning. It is marked by the bulging of the cervical ridge on the labial and lingual surfaces. While there is usually a well-defined constriction on the tooth at this point, the *neck* of the tooth is not so marked as in some of the distal teeth.

The Root.—This is conical in shape, and when viewed from the labial surface (Fig. 1) its sides converge in almost straight lines to a rounded

point; but viewed from the mesial (Fig. 3) or distal side the outlines of the root curve to a rounded point. When viewed in cross-section at the neck the labio-lingual diameter of the root is greater than the mesio-distal and the root outline is that of a rounded triangle with its sides corresponding to the labial, mesial, and disto-lingual faces of the root. Of these the mesial is the longest and nearly straight, the labial and disto-lingual being approximately equal in length but the labial is the most curved of all.

Fig. 7.—Left Upper Central Incisor. Cross-section at cervix showing pulp chamber in crown. Looking crownward.

The Pulp Cavity.—The form of the pulp cavity of the central incisor corresponds in general with the external form of the tooth itself (Fig. 6). It is divisible into the *pulp chamber* and the *pulp canal*, but the line of division is not clearly marked. The pulp chamber occupies the crown of the tooth and, as seen in a labio-lingual section of the tooth (Fig. 6), follows the form of the crown closely. The pulp canal is conic in form, with its base joining the pulp chamber and its apex reaching the apex of the root where it terminates in the apical foramen. In a cross-section of the tooth-crown the flattening out of the incisal end of the pulp chamber to follow the incisive edge of the tooth, is seen. (Fig. 9.) The portions extending in the direction of the angles of the tooth are known as the "horns" of the pulp. In the young subject there are three concavities in its occlusal end, corresponding to the three tubercles and the three developmental centers of the incisive edge of the crown. A cross-section of the root at the cervix shows the pulp cavity almost circular in outline (Fig. 8), and this form characterizes it to the end of the root. The pulp cavity of this, as of all the teeth, diminishes in size from the time of completion of the root through old age because of the deposit of dentin upon its walls (Fig. 8).

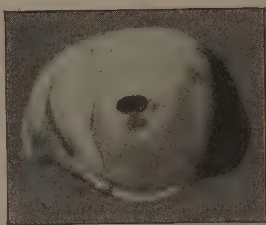


Fig. 8.—Left Upper Central Incisor. Cross-section at cervix showing small pulp cavity in old tooth. Looking crownward.

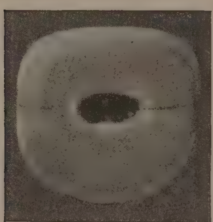


Fig. 9.—Right Upper Central Incisor. Cross-section made at middle of crown (looking rootward) showing form of pulp chamber.

THE UPPER LATERAL INCISOR

The Labial Surface (Fig. 10).—This surface is somewhat similar in outline to that of the central incisor except that it is smaller, being narrower from side to side and shorter, and its distal angle is

more rounded. It is bordered by four margins. The incisive margin is almost straight, being, however, inclined slightly downward in the direction of the median line and in the young tooth is marked by developmental grooves which are less prominent than those of the central incisor. The mesial margin is nearly straight from the mesial angle to the cervix, being sometimes, however, slightly concave which causes a hook-like appearance to this surface of the tooth. The cervical margin is markedly convex rootward since the tooth is narrower than the central incisor, while the distal

Fig. 10.—Right Upper Lateral Incisor. Labial Surface.

Fig. 11.—Right Upper Lateral Incisor. Lingual Surface.

margin is also made convex from the projection of its distal angle. The latter is longer than the mesial margin circumferentially, but a straight line drawn from the distal angle to the cervix shows that this portion of the face is shorter than the mesial portion. The labial surface is more rounded in every way than that of the central. The *cervical ridge* and developmental grooves are present but are not so pronounced.

The Lingual Surface (Fig. 11).—Like that of the central incisor, this surface is usually slightly concave, which is due to the projection of the mesial, distal and cervical marginal ridges. In outline it is nearly triangular. The incisive margin is the same shape as that described for the labial surface. The *mesial and distal marginal ridges* are well marked and unite

with the cervical ridge. Both the mesial and distal margins are usually convex although the mesial may be almost straight. The distal is much shorter. The cervical margin is formed by the *cervical ridge* and is more frequently the seat of a *cingulum* than that of the central incisor. While the surface is usually concave in all directions, in some instances it may be almost flat. There is normally a well-defined *fossa* and in some cases this latter is marked with a *longitudinal ridge* corresponding to that on the labial face.

Fig. 12.—Right Upper Lateral Incisor. Mesial Surface.

Fig. 13.—Right Upper Lateral Incisor Distal Surface.

The Mesial Surface (Fig. 12).—Shaped like an arrow-head, the cervical margin being concave, the labial margin of this surface is convex with a long curve. The lingual margin is less distinctly marked, is concave, and unites with the labial at the mesial angle of the crown. The surface is convex in its lower two-thirds but becomes flattened toward the cervix where sometimes a pronounced depression may exist. The point of contact with the central incisor is about one-third the distance from the cutting edge.

The Distal Surface (Fig. 13).—This has the same general outline as the mesial but is more rounded in every way. The cervical margin is similar to that on the mesial face but the labial and lingual are shorter, meeting

at the distal angle which is less sharp and nearer the gingival margin than the mesial angle. The prominence of this surface makes this tooth quite different from the other incisors and the surface is more nearly the shape of the mesial surface of the cuspid with which it is in contact.

The Cervical Margin.—Although like the central in general characteristics, the labial and lingual portions of this line are more convex rootward, the latter being a sharper curve and extending proportionately higher than the labial. The mesial and distal portions are concave rootward, are similar in general form, and are quite angular.

The Incisive Edge (Fig. 14).—This is proportionately shorter than that of the central, is often a nearly straight line between the angles of the crown and is usually slightly curved in a labial direction as the tooth, is viewed from below. Like the central incisor, at the time of its eruption it displays usually three developmental tubercles which indicate the three points at which calcification begins, but these are soon worn off.

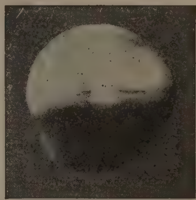


Fig. 14.—Right Upper Lateral Incisor. Incisal View.

The Root.—The root of the lateral incisor has a general conical form, is often slightly longer than that of the central incisor, and is flattened mesio-distally. Its extremity usually has a slight distal bend. At the neck of the tooth it is almost circular in cross-section and is again at the apex, but the intervening portion exhibits the flattening above referred to and in some instances pronounced grooves upon the mesial and distal surfaces. In the center of its length the root is approximately one-third greater in labio-lingual diameter than mesio-distally.

The Pulp Cavity.—This corresponds in form to that of the tooth and differs but little except in size from that of the central incisor.

THE LOWER CENTRAL INCISOR

This is the smallest tooth in the mouth. Its crown is wedge-shaped (Fig. 17).

The Labial Surface (Fig. 15).—In outline this face of the crown is nearly triangular, the incisive margin being the base while the mesial and distal margins converge to the rounded apex formed by the cervical margin. The incisive edge is nearly straight and almost at right angles with the long axis of the tooth. The mesial and distal margins are long curves, the distal being very slightly shorter and more curved. The cervical border is very short; the surface is convex from incisive edge to cervix, and, when seen in profile, is almost exactly the arc of a circle. Near the incisive edge the surface is nearly straight, the division between

it and the mesial distal surfaces being marked by fairly well-defined angles; as the cervix is approached, however, it becomes more rounded. Like the upper incisors it is sometimes marked by two developmental grooves but these are normally poorly discernible except in young teeth.

The Lingual Surface (Fig. 16).—Like the labial surface this is nearly triangular in outline but the rounded apex formed by the cervical margin is more nearly an acute angle. The surface is concave from incisive margin to the cervical ridge when this latter causes it to be marked with a convexity which ends abruptly by a well-defined margin at the neck of the tooth. The mesial and distal marginal ridges are usually poorly

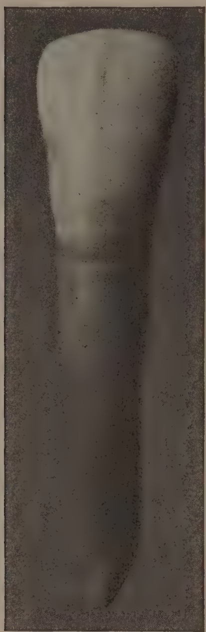


Fig. 15.—Right Lower Central Incisor. Labial Surface.

Fig. 16.—Right Lower Central Incisor. Lingual Surface.

defined, the cervical ridge in which they unite corresponding with them in this particular except that it is usually somewhat more easily traced. The incisal third of this surface is usually slightly bowed in a labial direction, making it concave mesio-distally, but this concavity gradually disappears before the center of the surface is reached.

The Mesial Surface (Fig. 17).—This is triangular in outline, but unlike the labial and lingual surfaces the base of the triangle is directed rootward and is formed by a concave cervical margin. The sides of the triangle formed by the labial and lingual margins are curved in a labial direction,

the labial being shorter and more curved and meeting the lingual at the mesial angle of the tooth. This surface is slightly convex, being most markedly so at its center just above which point it is in contact with its fellow of the opposite side.

The Distal Surface (Fig. 18).—This is similar in outline and contour to the mesial surface, except that it is slightly shorter and is more convex in its incisive third because the labial and lingual margins meet in a more rounded eminence the distal angle. Near the cervical margin it is often slightly concave, in which instance the concavity is commonly continued up the root as a longitudinal depression.

Fig. 17.—Right Lower Central Incisor. Mesial Surface.

Fig. 18.—Right Lower Central Incisor. Distal Surface.

The Incisive Edge (Figs. 15 and 19).—Like those of the upper jaw the lower central incisor at the time of its eruption is usually characterized by the presence of three tubercles upon its incisive edge. These are soon worn off and the edge is then straight. It occupies a line at right angles to the long axis of the tooth, terminating in the mesial and distal angles of which the former is slightly the more pronounced.

The Cervical Margin.—This is similar in outline to that of the upper incisors except that it is more angular. On the mesial and distal surfaces

it is markedly concave in the direction of the crown and extends rootward on the lingual and the labial surface. The lingual portion is short and angular, which latter characteristic is caused by the projection downward of the abrupt cervical ridge of this surface of the crown. The labial portion of the cervical margin is convex rootward but less sharply so than the lingual.

FIG. 19.—Right Lower Central Incisor. Incisal View.

The Root.—The root on this tooth is more delicate than that of any other in the mouth. It is conical in shape, being much flattened upon its mesial and distal sides (Figs. 17 and 18) at the cervix from which point these surfaces slope in almost straight lines to the apex. This latter is sometimes slightly deflected in a distal direction. These sides of the root are frequently marked with longitudinal grooves which extend almost to the apex. The labial and lingual aspects of the root are narrow, the former being the wider and they converge gradually to within a short distance of the apex when they rapidly approach each other and give the root a rounded appearance which is observed when it is viewed from the mesial or distal side. The labial surface of the root continues the line of that surface of the crown, making with it almost a perfect arc of a circle.

FIG. 20.—Right Lower Central Incisor. Labio-lingual longitudinal section showing bifurcation of pulp canal.

The Pulp Cavity.—This cavity follows the general form of the exterior of the tooth and only a few points need to be touched upon in its description. The horns of the pulp chamber extend well toward the mesial and distal surfaces, but the cavity is very narrow labio-lingually at its extremity. There is no perceptible line of division between this and the pulp canal. The latter is flattened and narrow in its beginning at the cervix (Fig. 20) and occasionally divides into two canals which usually unite near the apex and terminate in a single foramen. In most instances, however, it exists as a small, slightly flattened canal.

FIG. 21.—Right Lower Central Incisor. Cross-section of crown near its middle looking rootward.

THE LOWER LATERAL INCISOR

This tooth so nearly resembles the lower central incisor that separate description seems superfluous, therefore only its differentiating characteristics will be pointed out. It is wider mesio-distally than the lower central incisor; its distal angle is more rounded and its distal surface slightly more convex. Its root is somewhat longer than that of the lower central incisor and at its apex is often bent distally. The pulp chamber is similar in all respects to that of the lower central incisor except that it is slightly larger in its coronal portion in correspondence with the greater size of the crown.

THE UPPER CUSPID

The crown of this tooth presents for examination four surfaces and a cusp.

The Labial Surface (Fig. 22).—The outline of this surface shows that it is bounded with five margins. The incisal portion provides two, the mesial

FIG. 22.—Right Upper Cuspid. Labial Surface.

FIG. 23.—Right Upper Cuspid. Lingual Surface.

and distal incisive edges. The former of these extends from the point of the cusp to the mesial angle, being either concave because of the presence of a developmental groove or it may be slightly convex. The distal incisive margin which extends from the cusp to the distal angle is usually

longer than the mesial incisive and more frequently marked with a slight convexity. The wearing down of the cusp in adult teeth usually results in making the point of separation between these margins less distinct. The mesial margin of the labial surface is convex, as is also the distal which descends from the distal angle of the crown. The cervical margin follows very much the same curve as that of the central incisor, the highest portion of its convexity, however, being a little nearer its mesial end. The surface is convex from cusp to cervix and also from the mesial to the distal angle

FIG. 24.—Right Upper Cuspid. Mesial Surface.

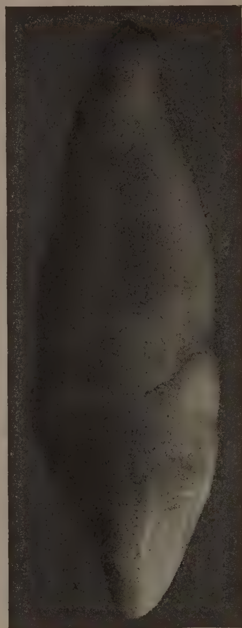


FIG. 25.—Right Upper Cuspid. Distal Surface.

but is sometimes marked by two longitudinal developmental grooves. These, beginning nearer the mesial and distal angles than the cusp of the crown, ascend toward the cervix, gradually disappearing about the upper third of the surface. The labial ridge ascends from the cusp, being located nearer the mesial than the distal surface of the crown, and gradually blends with the rounded convexity of the upper third of this surface. When the developmental grooves are not marked the labial surface mesial to the ridge is more convex than that distal to it.

The Lingual Surface (Fig. 23).—With much the same outline as the labial face, this surface is slightly smaller, but is proportionately longer from cusp to cervix, and has a shorter and more convex cervical margin.

The surface has a general convexity and is marked by a lingual ridge which ascends from the cusp and does not fade away until it reaches the cervical marginal ridge. It corresponds in position to the labial ridge of the opposite face of the crown. In distinctly marked teeth there is a groove on either side of this ridge. The cervical marginal ridge is usually a pronounced, rounded elevation affording a distinct line of demarcation between the crown and root of this tooth. It is frequently the seat of an elevation at or near its center, and may have a fissure dividing the ridge on either or both sides of the cingulum. The mesial and distal marginal ridges are less well marked than the cervical from which they extend to the mesial and distal angles of the crown. The mesial is the longer and better defined.

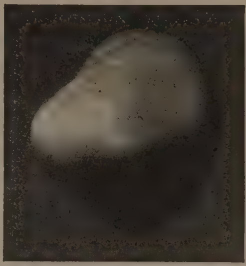


FIG. 26.—Right Upper Cuspid Incisal View.

The Mesial Surface (Fig. 24).—Shaped like an arrow-head, the labial boundary convex and the lingual usually concave, the outline of this surface is completed by the concave cervical margin. The lowest portion of this latter is slightly nearer its junction with the labial than with the lingual margin. The mesial angle which is the meeting ground of the labial and lingual margins is just below the point at which this tooth is in contact with the lateral incisor. It is not quite so near the cervix as is the distal angle. The surface is nearly convex in its lower two-thirds but above this point may be flat or slightly concave.

FIG. 27.—Right Upper Cuspid. Longitudinal section cut antero-posteriorly showing pulp cavity.

The Distal Surface (Fig. 25).—This is similar in shape to the mesial but is somewhat smaller in extent and more convex. The distal angle is more protuberant than the mesial and just above it is a rounded point with which the tooth is in contact with the first bicuspid. The cervical margin is less concave than the mesial and its highest portion is nearer the labial than the lingual margin.

The Cusp (Fig. 26).—This is the prominent point of the cutting edge and is formed by the union of the mesial and distal cutting edges and the labial and lingual ridges. It is sharp in well-marked teeth at the time of eruption but the point is soon worn down and may be blunt or rounded.

The Cervical Margin.—Convex labially and lingually and concave mesially and distally, this margin corresponds closely to that of the upper central incisor.

The Root.—Like that of all single-rooted teeth the root of the upper cuspid is conical. On all its four sides it gradually tapers from the cervix to the apex. In cross-section at the cervical margins (Fig. 28) it is ovoid or may be almost circular. In the former instance the labial side is the segment of a larger circe than the lingual. The mesial and distal aspects of the roots are often flattened, in which case their centers sometimes present poorly marked longitudinal grooves. At the apex the root is usually inclined in a distal direction or the whole root may have a slight distal curve.

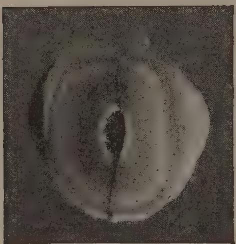


FIG. 28.—Right Upper Cuspid. Cross-section at cervix looking downward, showing shape of pulp cavity.

The Pulp Cavity (Figs. 27 and 28).—In the young tooth there is a pronounced projection of the pulp chamber wall toward the cusp of this tooth, but as it becomes more mature the pulp cavity becomes more flattened here. Otherwise it is very much like the external form of the tooth, extending well toward the mesial and distal angles, and closely resembling that of the central incisor. At the level of the cervix it is oval in cross-section and extends gradually diminishing in size to the apex. There is no line of demarcation between the root and coronal portion of the cavity.

THE LOWER CUSPID

The crown of the cuspid of the lower series is very similar to that of the upper, except that it is narrower, more delicate and slightly longer, and usually not so well marked.

The Labial Surface.—The markings of this surface are not so pronounced as those of the upper cuspid. The outline is less angular than that of the upper, with the exception of that portion formed by the mesial and distal incisive edges, for its cusp is more pointed than that of the upper cuspid. The developmental grooves are usually poorly defined, the labial ridge being the most prominent marking of this surface and giving to it a marked convexity. This ridge, as in the upper cuspid, is located decidedly nearer the mesial than the distal margin. The mesial margin is more pronounced than the distal, the labial surface meeting the mesial somewhat more abruptly than the distal into which it passes by a rounded curve without definition.

The Lingual Surface.—The outline is more rounded and the surface markings less bold than those of the upper cuspid. The marginal

ridges are usually poorly defined, that at the cervix being more prominent than the mesial or distal. The lingual ridge extends from the cusp to the cervix, dividing this surface and forming two very shallow grooves or fossæ, the lingual grooves; but the surface is less convex than that of the upper, especially at the occlusal end, which is sometimes flat mesio-distally.

The Mesial Surface.—Similar in shape to that of the upper, yet differing from it in some particulars, this surface of the lower cuspid possesses the peculiarity of being almost flat and being continuous as an almost plane surface with the root. At the cervix it is slightly concave or it may be simply flat, but it assumes a convex character as the mesial angle is approached. The cervical outline is much less concave rootward than that of this face of the upper cuspid, but similarly it extends to a lower level lingually than labially. The lingual margin is well defined but the labial is rounded.

The Distal Surface.—The convexity characteristic of this surface of the upper cuspid is observed here, except that the cervical portion is sometimes slightly concave. The surface is smaller in extent than the mesial, a fact due to the lower location of the distal angle. The cervical margin is pronounced, the surface of the root usually forming a decided angle with that of the crown. The lingual margin is more marked than the labial, but by comparison both are less clearly defined than those on the mesial surface.

The Cusp.—The prominent point of the tooth occupies a line almost in its long axis. From it descend the mesial and distal incisal edges of which the latter is slightly longer, but the difference is not so marked as in the upper cuspid.

The Cervical Margin.—This is concave in the direction of the root on the labial and lingual sides and convex on the mesial and distal. On the lingual and distal sides the root and crown join more abruptly than on the mesial and labial.

The Root.—The root is shorter than that of the upper cuspid and is flattened on its mesial and distal sides. Viewed in profile from any of the four surfaces its sides slope gradually to the apex which is frequently inclined to the distal.

The Pulp Cavity.—This resembles that of the upper cuspid except that it is narrower mesio-distally, a difference in form likewise observable in the crowns of the two teeth. It has no horns of the pulp chamber but terminates in a pointed extremity beneath the cusp. The pulp canal is flattened mesio-distally at the cervix but becomes circular in its apical portion.

THE UPPER FIRST BICUSPID

The crown of this tooth presents for examination five surfaces, namely, occlusal, buccal, lingual, mesial and distal. It is irregularly cuboidal in shape.

The Occlusal Surface (Fig. 29).—When viewed from the occlusal surface the crown appears ovoid in outline, whereas the occlusal surface proper is trapezoidal, the oval appearance being due to the projection of the buccal and lingual faces of the tooth. The most prominent features of this surface are the two cusps surmounting its buccal and lingual portions, the buccal and lingual cusps, which are separated by the central groove and which give to the tooth its distinguishing character (bicuspid). The margins are formed by the buccal cusp with its descending mesial and distal inclines, the mesial and distal marginal ridges, which are well-defined ridges of enamel joining the ridges of the buccal cusp at the mesial and distal angles of the crown and converge to join descending ridges from the lingual cusp and the lingual cusp itself.

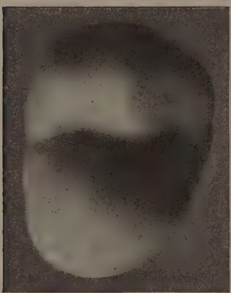


Fig. 29.—Left Upper First Bicuspid. Occlusal Surface.

The *buccal cusp* is the larger, sharper and more prominent. From its summit four ridges descend; the buccal ridge, which is partly responsible for the prominence of the buccal surface of the crown; the triangular ridge, which extends downward toward the central groove and usually terminates there; and one each mesially and distally to reach the mesial and distal angles respectively. Of these latter two, the distal is usually the larger and the more inclined, the point of the cusp being usually nearer the mesial than the distal face of the crown.

The lingual cusp is lower and much more rounded than the buccal and the three ridges descending from it are less pronounced. The triangular ridge is often missing but when present it descends toward the central groove to meet the ridge from the buccal cusp. Occasionally these two triangular ridges unite and form the transverse ridge, but usually they are separated by a fissure in the central groove. The ridges descending mesially and distally from this cusp join and are continuous with the marginal ridges, being curved so that the lingual outline of the occlusal surface is much rounded. The lingual aspect of the lingual cusp is convex and rounded and gradually blends with the lingual surface.

The mesio-distal groove separates the cusps and extends from the mesial to the distal marginal ridges. It is sometimes extended at each extremity into the mesial and distal developmental grooves which when

present are fine lines crossing the marginal ridges to reach the mesial and distal surfaces of the crown. The triangular grooves are short, cross the central groove at its terminations at right angles, extend toward the angles of the crown, and separate the mesial and distal marginal ridges from the triangular ridges. The junctions of these grooves with the central groove are often spoken of as the mesial and distal pits.

The Buccal Surface (Fig. 30).—This closely resembles in form and outline the labial surface of the cuspid tooth, being smaller and more

FIG. 30.—Left Upper First Bicuspid. Buccal Surface.

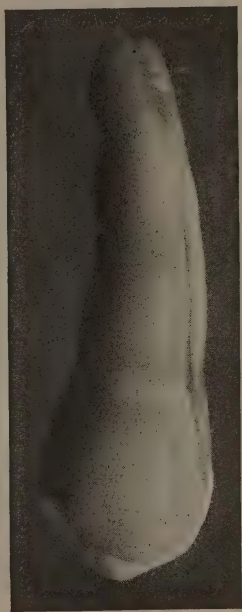


FIG. 31.—Left Upper First Bicuspid. Lingual Surface.

compressed occluso-gingivally. It is bounded by four margins, the occlusal the cervical, the mesial and the distal. The occlusal is formed by the mesial and distal inclines of the buccal cusp and is well defined. The mesial incline is usually a straight line or is slightly convex, while the distal may be marked with a concavity caused by the distal buccal groove. The mesial border is more sharply defined than the distal. It descends from the mesial angle to the cervical border, which latter is nearly straight or may be slightly convex rootward and is not distinctly marked by an abrupt termination of the enamel. The distal margin is usually shorter and more rounded than the mesial, because of the lower position of the distal angle, and the fact that the buccal surface rounds into the distal without a sharp line of definition. The buccal ridge, descending from the buccal cusp

and flanked by the buccal developmental grooves, which are forced well towards the angles of the crown, contributes towards the convexity of this surface. It usually disappears by blending with this convexity about the center of the surface, but occasionally in well-marked teeth it extends almost to the cervical margin. The greater mesio-distal diameter of the crown at the level of the angles than at the cervical margin gives to the crown its characteristic bell-shape, which may be well observed when looking at it from the buccal side.

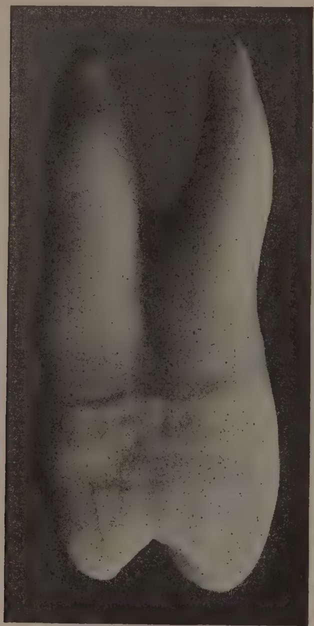


FIG. 32.—Left Upper First Bicuspid. Mesial Surface.

FIG. 33.—Left Upper First Bicuspid. Distal Surface.

The Lingual Surface (Fig. 31).—This face is smaller than the buccal, being both shorter and narrower. It is convex mesio-distally and rounds into the mesial and distal face without line of demarcation. Its occlusal margin is also rounded, being formed by the lingual cusp and the ridges descending from it, while the gingival margin is either nearly straight or is only slightly convex rootward. The surface is curved from the summit of the lingual cusp, which is slightly nearer the mesial face of the crown, to the cervix, its outline when seen in profile being a long gentle curve. It is usually quite smooth and without grooves.

The Mesial Surface (Fig. 32).—Irregularly quadrilateral in shape, this face of the crown is bordered occlusally by the mesial marginal ridge and a portion of the ridge from the lingual cusp, and gingivally by the cervical

line which is usually nearly straight or slightly concave in the direction of the root. The occlusal margin is concave, the concavity being about midway between the cusps. Frequently this margin is broken by the mesial developmental groove which reaches this face from the occlusal surface and usually terminates about its center. The buccal margin is fairly well defined and extends from the mesial angle to the cervix, while the lingual is so rounded by the gradual joining of the lingual surface as to be indistinguishable. Near the occlusal margin the surface is full and rounded, giving a point of contact for the proximal side of the cuspid, but it flattens out as the cervix is approached and in this location is usually the seat of a depression which is continued up the face of the root.

FIG. 34.—Left Upper First Bicuspid. Bucco-lingual longitudinal section, showing pulp chamber, its horns, and the pulp canals.

The Distal Surface (Fig. 33).—While this is much like the mesial surface, it is smaller in extent and more convex. The buccal margin is not so pronounced as that of the mesial face and is usually shorter. The cervical, lingual and occlusal margins are very much like those of the mesial face and the lingual is poorly defined and much rounded. In its occlusal third the surface is quite convex in all directions and this usually extends in decreasing degree to the cervix, although the corresponding portion of the mesial face is usually concave bucco-lingually. The distal developmental groove sometimes crosses the upper margin from the occlusal surface and disappears about the center of the surface.

The Cervical Margin.—This is more nearly straight around the tooth than that of any of the teeth so far described, usually having, however, a slight curve rootward on both buccal and lingual surfaces and being curved toward the occlusal surface on the mesial and distal faces.

The Root.—The upper first bicuspid usually has two roots (Fig. 32) or two branches of its root, which are located beneath its two cusps and are called the buccal and lingual roots. Occasionally the tooth has only one root, or the division may occur very near its apex. In the former instance the central portion of the root between the two pulp canals is thin and usually consists only of cementum. The occurrence of two separated roots is most frequently noted and in this instance the roots are delicate and taper gradually to a somewhat sharp apical extremity and

are usually curved in several directions. These curves are usually first in a buccal and lingual direction, serving to separate the roots which again approach each other at their terminations. There is often a gentle distal curve in both roots. The bifurcation is usually located about one-third the distance from the cervix, and is accomplished by a meeting of the groove noted on the mesial face of the root and originating in the crown, with one which develops above the cervix on the distal side of the root.

The Pulp Cavity.—The pulp chamber and the pulp canal are usually differentiated in this tooth (Fig. 34), the chamber corresponding to the general shape of the crown, the canals to the form of the roots. The chamber is a cavity with flattened mesial and distal walls and curved buccal and lingual walls. In the mature tooth these latter are nearly parallel and terminate occlusally in the buccal and lingual horns of the pulp chamber, which are cone-shaped projections of the cavity penetrating the two cusps. The occlusal wall of the chamber is marked by a projection corresponding to the central groove of the occlusal surface of the crown. In horizontal cross-section at this level, the cavity is larger than at the cervix, the mesial and distal walls converging to this point in correspondence with the external surface of the crown.

Fig. 35.—Left Upper First Bicuspid. Cross-section of root near cervix, showing shape of pulp canal.

The floor of the pulp chamber, which is usually about on a level with the cervix, differs in character in accordance with the root formation of the tooth. In teeth with two roots or in those with two root canals, the buccal and lingual walls of the chamber are continued as the corresponding walls of the two pulp canals, but in old teeth a line of definition between the two is caused by an inward projection of the wall. The openings to the two canals are funnel-shaped and are separated by a ridge corresponding to the root bifurcation. The canals are usually about circular in cross-section, and follow the directions of the roots, occupying their centers. When the tooth has only one root, it sometimes has only one pulp canal (Fig. 35), which is flat and ribbonlike in its gingival portion, becoming more nearly round as the apex is reached. Often in single-rooted teeth there are two pulp canals, which either terminate in separate foramina close together or coalesce just before reaching the apex, a single canal making exit at the apex.

THE UPPER SECOND BICUSPID

This tooth so closely resembles the upper first bicuspid that it will only be necessary to point out the difference between the two. The

crown of the tooth is smaller and its prominences are more rounded than those of the first bicuspid. It is always shorter from cusps to cervix but the bucco-lingual diameter at the cervix is sometimes slightly greater than that of the first. On the occlusal surface (Fig. 36) both cusps are more rounded, and, unlike the first bicuspid, are usually of equal length. The lingual cusp is usually equal in size to that of the first bicuspid while the buccal is smaller, in consequence of which facts the two cusps of this tooth are approximately equal in size. The triangular ridges usually unite to form a transverse ridge, the central groove is shortened mesiodistally, and usually terminates in pits instead of well-marked triangular grooves. The buccal (Fig. 37) and lingual (Fig. 38) faces of the crown are smaller and more rounded than those of the first bicuspid, the mesial (Fig. 39) and distal (Fig. 40) faces being similar to those of the first except that the concavity

Fig. 36.—Right Upper Second Bicuspid. Occlusal Surface.

Fig. 37.—Right Upper Second Bicuspid. Buccal Surface.

Fig. 38.—Right Upper Second Bicuspid. Lingual Surface.

on its mesial face near the cervical margin is missing. This is one of the chief distinguishing features of the tooth. The cervical margin more

FIG. 39.—Right Upper Second Bicuspid. Mesial Surface.

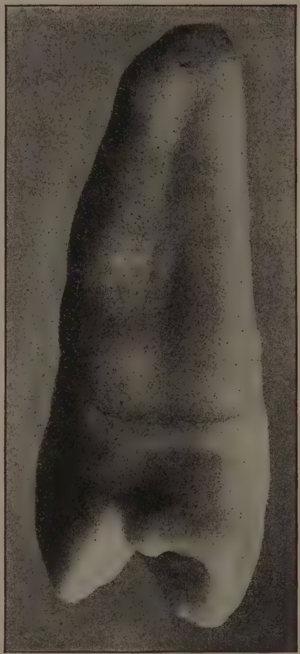


FIG. 40.—Right Upper Second Bicuspid. Distal Surface.

FIG. 41.—Right Upper Second Bicuspid. Bucco-lingual longitudinal section, showing pulp cavity.

FIG. 42.—Right Upper Second Bicuspid. Mesio-distal longitudinal section, looking buccally. Showing pulp cavity.

nearly occupies a horizontal plane than that of the first bicuspid, being slightly curved rootward on buccal and lingual surfaces and being almost straight on the mesial and distal sides. A dingle root is characteristic of this tooth. It is much flattened on its mesial and distal sides and is usually marked with a longitudinal groove on each of these surfaces. Its extremity is usually rounded and occasionally bifid. Its buccal and lingual surfaces converge much more in reaching the apex than do its mesial and distal. The root sometimes has a curve in a distal direction near its termination.

Fig. 43.—Right Upper Second Bicuspid. Cross-section of root above cervix, showing pulp canal.

Inasmuch as this tooth normally has but one root, the pulp cavity consists of a pulp chamber corresponding in shape to that of the crown and a single pulp canal (Fig. 41). While the pulp chamber is similar in form to that of the first bicuspid, the horns of the chamber are less pointed and penetrating, because of the differences in the cusps of these two teeth. The pulp canal has its walls continuous with those of the chamber, no definite demarcation between the two existing. It is narrow mesio-distally and ribbon-like at the cervix but is usually easy to enter (Fig. 43). Occasionally this tooth has two roots, in which case two root canals can be found, and their existence should be considered among the rare possibilities in the treatment of these teeth.

THE LOWER FIRST BICUSPID

While partaking of the characteristics of the upper bicuspid teeth, the lower first bicuspid departs from the typical bicuspid design in the rudimentary development of its lingual cusp. The great variation in the development of this cusp accounts for the variations in form so commonly observed in this tooth.

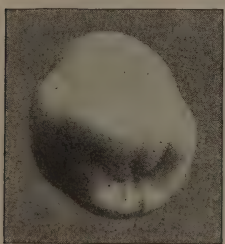


Fig. 44.—Left Lower First Bicuspid. Occlusal Surface.

The Occlusal Surface (Fig. 44).—Viewed from the occlusal surface the outline of the crown appears almost circular or ovoid but this is due to the fact that the upper portion of the bulging buccal face is visible. The surface presents for examination a buccal cusp, either a lingual cusp or a lingual ridge, a mesial and distal pit and marginal ridges bordering the surface. The summit of the buccal cusp is nearly in the line of the long axis of the crown. Four ridges descend from it, one each in a buccal, lingual, mesial and distal direction. The two latter unite at the mesial and distal angles with the marginal ridges.

The buccal extends upon the buccal face of the crown and the lingual is more strongly developed, is not crossed by a groove, reaches the lingual ridge or lingual cusp, and separates the mesial and distal pits. The mesial and distal marginal ridges converge to unite and form a semicircle with a lingual prominence of enamel, which when much elevated above the adjoining margin ridges is considered the lingual cusp and when only existing as a ridge is called the lingual marginal ridge.

The Buccal Surface (Fig. 45).—This corresponds so closely to that of an upper bicuspid that detailed description would be superfluous.

FIG. 45.—Left Lower First Bicuspid. Buccal Surface.

FIG. 46.—Left Lower First Bicuspid. Lingual Surface.

The cusp is not so pointed, the buccal developmental grooves are poorly developed, the crown is shorter and narrower than its fellow of the upper series, the cervical line is almost straight, and the surface is convex and slopes inward to the summit of the buccal cusp which is usually in line with the long axis of the root.

The Lingual Surface (Fig. 46).—This is small because of the small size and low position of the lingual cusp. The occlusal margin is well defined and the surface is nearly straight from this point to the cervix and in many instances is continued without marked division into the surface of the root or it may make an obtuse angle with this face of the root. Mesio-distally it is much rounded passing into the proximal surfaces with a gentle curve.

FIG. 47.—Left Lower First Bicuspid. Mesial Surface.

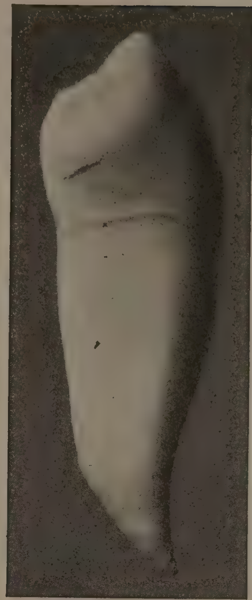


FIG. 48.—Left Lower First Bicuspid. Distal Surface.

FIG. 49.—Right Lower First Bicuspid. Mesio-distal longitudinal section, showing pulp cavity.

FIG. 50.—Right Lower First Bicuspid. Bucco-lingual longitudinal section, showing pulp cavity.

The Mesial Surface (Fig. 47).—Irregularly quadrilateral in outline, with only its occlusal margin well defined by the marginal ridge, this surface is generally convex. The most prominent point of the convexity is located centrally just below the occlusal margin from which the surface inclines inward toward the central axis of the tooth, contributing thereby to give the bell-shape which is observed of this crown as it is viewed from the buccal or lingual side. At the cervix the surface is flattened.

The Distal Surface (Fig. 48).—This is almost similar to the mesial except that its convexity is usually less pronounced.

The Cervical Margin.—The juncture between enamel and cementum in this tooth occupies nearly a horizontal plane, being continued around the tooth in almost a straight line. There is frequently a dip rootward on the buccal face.

The Root.—A single root normally characterizes the lower first bicuspid although in rare instances two roots are found. When single it is conical, the buccal and lingual sides being uniformly inclined toward each other and continuing these faces of the crown. The lingual is the narrower, which is caused by the fact that the flattened mesial and distal faces converge in passing lingually. These latter are usually slightly convex and uniformly taper to the apex, but occasionally they are marked with a shallow longitudinal depression. The end of the root is sharply pointed and is frequently deflected distally. The cervical portion of the root is oval in cross-section.

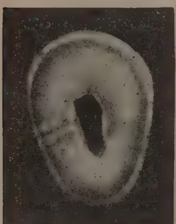


FIG. 51.—Right Lower First Bicuspid. Cross-section at cervix showing pulp canal.

The Pulp Cavity.—As in all single rooted teeth there is no sharp division between the pulp chamber and canal (Fig. 49). The chamber has one well-defined horn situated beneath the buccal cusp and when a lingual cusp exists there is a small projection of the cavity in its direction (Fig. 50). At the level of the gingival margin the cavity is oval in cross-section whence it continues diminishing in bucco-lingual diameter to the apical foramen (Fig. 51). It is usually small and thread-like in the apical third of the root.

THE LOWER SECOND BICUSPID

While this tooth bears a close resemblance to the lower first bicuspid tooth in many particulars, in some details it is quite different. These latter chiefly pertain to the lingual portion of the occlusal face of the crown and the adjacent surfaces to which this is related. In general the crown of the tooth is smaller and more rounded than the first. Viewed

from the occlusal face it will be seen that this surface is larger and even more nearly circular in outline than the first. In some instances this is due to the presence of a well-developed lingual cusp and prominent marginal ridges mesially and distally. In other instances the same rounded outline is caused by the presence of two lingual cusps, a fissure dividing the lingual portion in its center. The buccal cusp is less prominent than that of the first bicuspid, and has a well-defined triangular ridge which seldom unites with that of the lingual cusp. When present the lingual cusp is smaller than and not so prominent as the buccal and is usually separated from it by a mesio-distal groove. This latter terminates in pits, the mesial and distal pits, and is curved lingually. When the face presents three cusps the groove has three branches meeting in a central pit or fossa. The angles of the crown are not well marked.

The buccal surface is more rounded and shorter and wider than that of the first bicuspid. The lingual surface is proportionally larger than the lingual of the lower first bicuspid, being longer occluso-gingivally because of the lingual cusp at the base of which it is also wider mesio-distally. The mesial and distal faces of the crown are similar to those of the first bicuspid except that they are wider bucco-lingually and are both slightly more convex. The cervical margin encircles the tooth almost in a horizontal plane, but a curve rootward may usually be made out on the buccal face. The single root is conical, proportionately longer than that of the first bicuspid, flattened on its mesial and distal sides, and usually bent distally in its lower portion. The pulp cavity is larger than that of the first bicuspid, the chamber being shaped to correspond with the external surface of the crown and having the rudimentary lingual horn better developed. The canal is oval or circular in cross-section at the cervix from whence it tapers gradually to the apical foramen.

THE UPPER FIRST MOLAR

The crown of the upper first molar is roughly cuboidal in shape and offers for examination five surfaces—occlusal, buccal, lingual, mesial and distal.

The Occlusal Surface (Fig. 52).—This is irregularly rhomboidal in outline as may be seen when the crown is viewed from this surface. The mesial and distal margins are nearly straight and parallel; the buccal and lingual margins are curved. At the mesio-buccal and disto-lingual juncture of these margins acute angles are formed while the angles at the disto-buccal and mesio-lingual juncture are obtuse. The surface is marked by the presence of four cusps, four marginal ridges, two fossæ, and several developmental grooves. The mesial marginal ridge is a rounded and well-defined elevation of enamel extending from the summit

of the mesio-buccal cusp to that of the mesio-lingual cusp, and is curved rootward between these points. It is often crossed near its center by the mesial developmental groove which extends from the occlusal to the mesial surface. The buccal marginal ridge unites with the mesial at the mesio-buccal angle of the tooth. It extends from this point to the point of the mesio-buccal cusp, then in a slightly lingual direction to the bottom of the buccal groove, then buccally to the point of the disto-buccal cusp and then to the disto-buccal angle, being curved latterly in a lingual direction to unite with the distal marginal ridge. It is the sharpest of the marginal ridges, a fact in large part due to the sharpness of the buccal cusps.

FIG. 52.—Left Upper First Molar. Occlusal Surface.

The distal marginal ridge is similar to the mesial in that it is curved rootward between its terminations and is a rounded ridge of enamel. It is marked to the buccal side of its center by the distal groove, which passes over upon the distal face of the crown. The lingual termination is well rounded and consequently less easily differentiated from the disto-lingual cusp in which it terminates. The lingual marginal ridge completes the periphery of the occlusal surface, extending from the disto-lingual to the mesio-lingual angle of the crown. From its mesial end it curves lingually to the summit of the mesio-lingual cusp, then buccally to the point where it is divided by the disto-lingual cusp and then lingually again to the top of the disto-lingual cusp. It is the most rounded of the marginal ridges.

The Cusps.—The upper first molar may be said to possess four cusps normally but in a large number of cases it has five. The mesio-buccal cusp, located near the mesio-buccal angle of the tooth, is sharp and from its summit descend four ridges. These latter are the buccal, which continues upon the buccal surface of the crown, the triangular which descends into the central fossa, and the two ridges descending mesially and distally forming portions of the buccal marginal ridge. The disto-buccal cusp is somewhat smaller than the one just described, but like it is sharp and has four ridges descending from its point. The buccal ridge descends upon the buccal face, the mesial and distal ridges are portions of the buccal marginal, while the fourth ridge unites with one from the mesio-lingual cusp to form the oblique ridge. The disto-lingual cusp is usually the smallest (except the fifth) and is rounded. But two ridges descend from it, one each in a mesial and lingual direction to form the marginal ridge of

these boundaries. Its lingual and distal aspects fade off into these respective faces of the crown without demarcation. It is separated from the oblique ridge by the disto-lingual groove. The mesio-lingual cusp is frequently the largest cusp of this tooth. It is much rounded and has ridges descending from it as follows: one to the mesial to join the mesial marginal ridge, while one passes in the direction of the disto-buccal cusp, meeting a ridge from the latter to form the oblique ridge. The buccal aspect of the cusp forms a wall of the central fossa, while the lingual

FIG. 53.—Left Upper First Molar. Buccal Surface.

FIG. 54.—Left Upper First Molar. Lingual Surface.

side is rounded and descends without demarcation into the lingual surface of the crown, or in teeth with a fifth cusp descends into the groove dividing the latter from the crown. The fifth cusp, or lingual cingule as it is sometimes called, varies much in size and occurrence. When present it is an elevation of enamel on the lingual surface of the crown, near and just distal to the mesio-lingual angle and at the lingual base of the mesio-lingual cusp from which it is separated by a groove, the mesio-lingual.

The Fossæ and Grooves.—The central fossa is triangular in shape and occupies the space between the mesio-buccal, disto-buccal and mesio-lingual cusps, its walls being formed by the central inclines of these cusps and the mesial marginal ridge. In its center is the central pit from which radiate the mesial developmental groove, which passes

forward over the mesial marginal ridge to the mesial face of the crown, the buccal groove which divides the mesio-buccal from the disto-buccal cusp and reaches the buccal surface of the crown, and the distal which is less well marked and passes distally over the oblique ridge. Each of these grooves may be the seat of a fault or fissure, the buccal exhibiting it more commonly and the distal less commonly than the others. The distal fossa is smaller than the central and is located between the disto-lingual and disto-buccal cusps and the distal marginal and oblique ridges. Its longest dimension is disto-lingually in which direction it is traversed by the disto-lingual groove. This latter has its terminations in the lingual pit near the center of the lingual surface and a pit in the distal fossa. It is parallel to the oblique ridge, dividing the disto-lingual cusp from this, and is usually the seat of a fissure, the result of faulty union of the developmental lobes of the crown. The distal groove passes through this fossa, crossing the oblique ridge anteriorly and the distal marginal ridge posteriorly.

FIG. 55.—Left Upper First Molar. Mesial Surface.

The Buccal Surface (Fig. 53).—This is bounded by four margins, of which the occlusal is irregular, sharp and prominent, being formed by the buccal marginal ridge and the two buccal cusps, the cervical is almost straight, while the mesial and distal are not well marked, the distal being less so than the mesial. The two latter are rounded and fade into the respective faces of the crown. They converge from the occlusal surface to the cervix, so that when the tooth is viewed from the buccal face the bell-shape of its crown is noticeable. For the most part the surface is slightly convex having, however, a depression near its center in which is frequently located a buccal pit. The buccal groove divides it into two lobes and usually terminates in the buccal pit, but the depression is sometimes continued rootward and is continuous with that between the two buccal roots. At the cervix there is a ridge of enamel, the cervical ridge, which gives prominence to this line.

The Lingual Surface (Fig. 54).—This is somewhat similar in outline to the buccal, but is narrowed mesio-distally at the cervix as the

sides converge to a single root instead of two as upon the buccal surface. The surface is more convex than the buccal, but, like it, is often the seat of a pit near its center, the lingual pit, in which the disto-lingual groove terminates. The depression caused by this groove is often continued rootward, dividing the surface into two lobes, and being continuous with a longitudinal depression upon the lingual root. The distal lobe is rounded in every direction, its distal portion being continuous with the distal face of the crown without demarcation. The mesial lobe resembles this in character except that its anterior margin is more defined. In those teeth with five cusps this lobe presents near the occlusal margin a rounded cingule, whose lingual side is continuous with the lingual face of the crown, but which is separated from the mesio-lingual cusp by a groove, the mesio-lingual groove. This latter often terminates distally by uniting with the disto-lingual groove, but frequently at each extremity it fades away into the surface of the tooth. The cervical line is almost straight, the mesial and distal margins are curved and converge toward the cervix, while the occlusal margin resembles that of the buccal face except that the cusp points are not so sharp and the marginal ridge is more rounded.

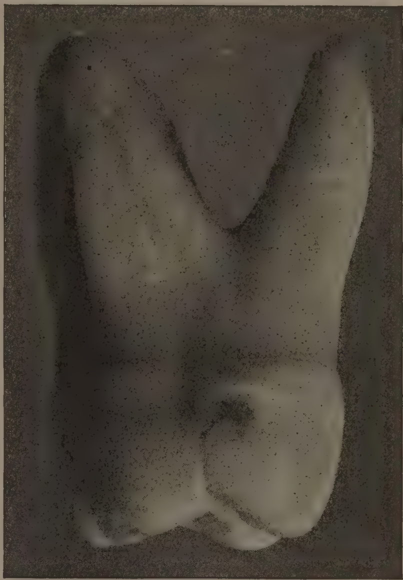


Fig. 56.—Left Upper First Molar. Distal Surface.

The Mesial Surface (Fig. 55).—While this is generally convex bucco-lingually near the occlusal margin, in its gingival two-thirds it is either flat or it may be slightly concave. It is either convex or nearly flat occluso-gingivally, and the most prominent point is slightly above the occlusal margin where the tooth is in contact with the second bicuspid. The surface is bounded by four margins—the cervical is usually concave in an occlusal direction, while the occlusal is concave in a cervical direction because of the mesial groove which is sometimes continued for a short distance upon this surface. The buccal and lingual margins are convex and converge to the occlusal surface. They are rounded, the former being better defined than the latter. The lingual margin is modified by the presence or absence of the lingual cingule, the location of the notch caused by the mesio-lingual groove varying according to the height of the cingule.

The Distal Surface (Fig. 56).—Four sided, this surface resembles the mesial in general outline. It is generally convex, except that often the distal groove is continued and makes a slight longitudinal depression near its center. The occlusal margin is more deeply notched than that of the mesial surface, the cervical line is nearly straight or concave occlusally while the buccal and lingual margins are rounded, the former being less well defined than the latter.

The Roots (Figs. 53 and 54).—These are three in number and are named from their location, the mesio-buccal, disto-buccal and lingual. They are not given off directly from the base of the crown, but the division which results in them occurs usually about one-third the distance from the cervix to the root apices.

The mesio-buccal root (Fig. 55) is flattened antero-posteriorly, and is next to the lingual in size and length. Viewed from its mesial side, it is nearly equal in width to half the crown and its sides slowly converge to near its end when they meet in a blunt, rounded point. From this view the root is inclined buccally, while viewed from the buccal side, it is seen to have a mesial inclination in its first third, curving then in a distal direction to its extremity. It is thin and flat mesio-distally.

The disto-buccal root (Fig. 56) is the smallest. It is narrower bucco-lingually than the mesio-buccal and is short. Its sides gradually incline to a more or less pointed apex, and it is slightly flattened mesio-distally. In its first third it is inclined distally, but in the remainder of its extent it is usually inclined mesially, approaching the mesio-buccal root.

The lingual root (Fig. 54) is the largest and usually the longest of the three roots. It is somewhat flattened bucco-lingually, and it is either nearly straight or slightly curved, in which latter instance its extremity is inclined buccally. It diverges markedly from the buccal roots in a lingual direction. Viewed from the lingual face the sides of the root are markedly convergent, sloping from the base of the crown to a somewhat rounded apex. This face of the root often presents a longitudinal depression which is continuous with that on the lingual side of the crown.

The Pulp Cavity (Fig. 57).—The pulp cavity is easily separable into the pulp chamber and the pulp canals, of which the former is approximately the shape of the exterior of the crown of the tooth, while the latter, which are three in number, correspond to the general external shape of the roots. The pulp chamber is characterized by four horns or depressions in its occlusal wall, one entering each of the four cusps. Its four lateral walls are parallel to the sides of the crown and are generally flat. In bell-shaped teeth they converge from the occlusal wall to the floor (Fig. 58) which is much smaller than the occlusal wall, while in teeth whose crown walls are

nearly parallel without constriction at the neck, the lateral pulp chamber walls are similarly disposed.

The horns of the pulp chamber are marked and penetrating and often persist in mature teeth as deep recesses in the dentin. The floor of the pulp chamber presents the three openings for the pulp canals. In the young adult tooth these are in the form of funnel-shaped openings. As age increases, the size of the pulp chamber decreases. The thickening of the lateral walls encroaches upon the pulp chamber, the funnel-like openings to the canals become simply small apertures and the canals are much reduced in size.

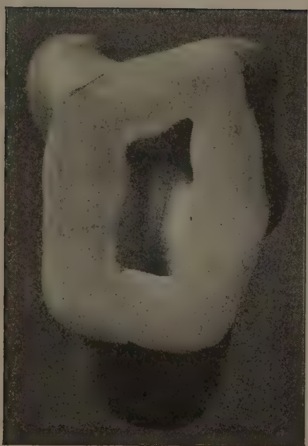


Fig. 57.—Right Upper First Molar. Cross-section below cervix, showing the pulp chamber and entrances to the pulp canals.

Fig. 58.—Right Upper First Molar. Longitudinal section cut through the pulp canals of the buccal roots, showing the pulp chamber and its horns.

The lingual canal (Fig. 57) is the largest and most accessible. It does not conform to the flattened shape of the root but is usually circular, decreasing gradually in caliber to the apex, and following the curvature of the root already noted. The entrance to it is directly under the middle of a line drawn from the summit of one lingual cusp to the other. The mesio-buccal canal (Fig. 58) is next in size and length. The entrance to it is very near the mesio-buccal angle of the tooth, slightly anterior to the summit of the mesio-buccal cusp. It is flat and ribbon-like and follows the curvature of the root. The disto-buccal

canal (Fig. 58) is small and thread-like. Its entrance is approximately under the disto-buccal cusp. It is short and difficult to enter.

THE UPPER SECOND MOLAR

The crown of this tooth differs from the first molar in any given denture in that it is flattened mesio-distally, with a rounding of the mesio-lingual and disto-buccal angles; its cusps are not so long and their summits are nearer the center of the tooth; it almost never possesses a fifth cusp or cingule, and the disto-lingual cusp is relatively smaller than that of the first molar.

FIG. 59.—Left Upper Second Molar. Occlusal Surface.

The Occlusal Surface (Fig. 59).—When the crown is viewed from the occlusal surface this latter is seen to be rhomboidal in outline but with the angles more rounded than those of the first molar and with the lingual margin almost semicircular. The mesial marginal, the distal marginal, the buccal and the lingual marginal ridges are formed as they are in the first molar. In this tooth they are more rounded. The mesio-buccal cusp has four ridges descending from its summit, one each in a buccal, lingual, mesial and distal direction. It is smaller and less sharp than the corresponding cusp of the first molar. The disto-buccal cusp is usually small and pressed in toward the center of the crown by the rounding of the disto-buccal angle. Its buccal ridge is absent or barely distinguishable. The mesio-lingual cusp is usually the largest cusp and is well rounded and without a clearly defined point. It has ridges which pass mesially, distally and bucally: the latter is heavy and strong and assists in forming the oblique ridge. The lingual surface of the cusp is much rounded. The disto-lingual cusp varies much in size and form. It is usually relatively smaller than that of the first molar. Often it is little more than an enlargement of the distal marginal ridge, with which its buccal ridge is continuous. Its distal and lingual faces are much rounded. The central fossa is not so deep as that of the first molar, though similarly its walls are formed by the two buccal cusps and the mesio-lingual together with the mesial marginal and oblique ridges. The mesial groove, the buccal groove and the distal groove all pass from it in these respective directions. It has a pit, the central pit, in its center, and the distal fossa has, similarly, the distal pit. From the latter fossa the distal groove passes to the distal surface and the disto-lingual to the lingual surface, ending on the latter usually in the lingual pit.

The Buccal Surface (Fig. 60).—This resembles that of the first molar so closely that only their points of difference need to be pointed out. The occlusal margin has the same outline as that of the first molar except that the smaller proportionate size of the disto-buccal cusp causes this portion to be slightly altered. The distal margin is more rounded and less pronounced than that of the first molar, but the other two margins are similar. The buccal groove continues upon the buccal face, from the occlusal surface, sometimes to the point of bifurcation of the roots, less

FIG. 60.—Left Upper Second Molar. Buccal Surface.

FIG. 61.—Left Upper Second Molar. Lingual Surface.

rarely ending in a buccal pit. The lobe of the crown mesial to the depression is always larger than the distal lobe. The cervical ridge is not so frequently marked.

The Lingual Surface (Fig. 61).—This differs in no wise from that of the first molar except that it is much more convex and the fifth cusp is almost never present to modify the form of its mesial portion.

The Mesial Surface (Fig. 62).—This resembles closely the corresponding surface of the upper first molar, but is relatively smaller and is often concave from buccal to lingual side. Its lingual margin is less well defined than its mesial.

The Distal Surface (Fig. 63).—Usually more convex than this surface of the first molar, and relatively shorter occluso-gingivally, the distal

Fig. 62.—Left Upper Second Molar. Mesial Surface.

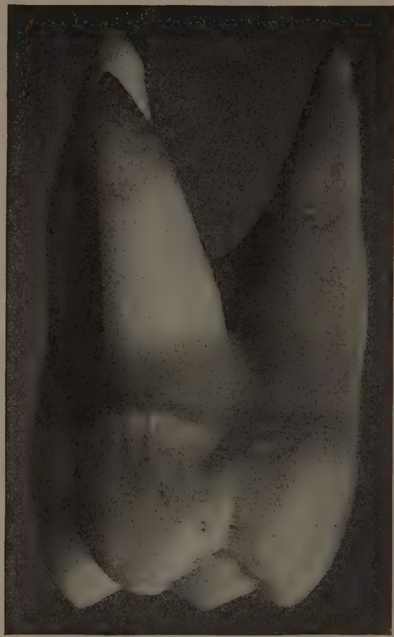


Fig. 63.—Left Upper Second Molar. Distal Surface.

surface of this tooth resembles in other respects its mesial neighbor. The varying size and portion of the disto-lingual cusp influence the exact form of this face of the crown.

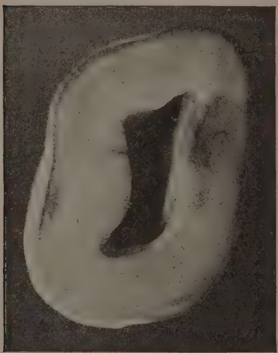


Fig. 64.—Right Upper Second Molar, Cross-section at cervix showing pulp chamber.

The Roots.—Alike in number and general form to those of the first molar, the roots of the second differ in some respects from them. The mesio-buccal (Fig. 62) is flattened antero-posteriorly, the disto-buccal (Fig. 63) is nearly conical, while the lingual root (Fig. 61) is longest, largest and flattened bucco-lingually but seldom exhibits the depression observed on this root of the first molar. The two buccal roots have a distinct distal inclination and tend to converge at their apices. The disto-buccal root occupies a position relatively more lingual than that of the first molar because of the flattening of the disto-buccal angle of the crown.

The Pulp Cavity.—The differences between the form of this and that of the first molar correspond to the differences in the surface forms of the two teeth.

The pulp chamber is flattened mesio-distally (Fig. 64) and the entrances to the canals are relatively nearer together and that of the disto-buccal canal is more lingually located. The horns of the pulp chamber are four in number but are smaller and less penetrating than those of the first molar. The root canals have the same shape as those of the first molar but are smaller and more difficult to enter (Fig. 65).

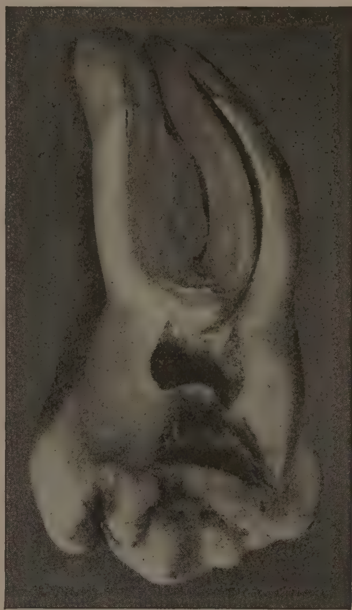


Fig. 65.—Right Upper Second Molar. Longitudinal Section cut through mesio-buccal root canal, showing pulp chamber.

THE UPPER THIRD MOLAR

Greater variation occurs in the form of this tooth than in that of any other in the dental series. In its typical form it has only three cusps, the disto-lingual cusp having disappeared, while in its most strongly developed form this is present but is much reduced in size by comparison with the other cusps of the tooth. Many atypical teeth are observed in which the cusp development is difficult to classify. A description will be given of the typical tooth.

The Occlusal Surface (Fig. 66).—This is marked by the presence of a mesio-buccal, a disto-buccal and a mesio-lingual cusp. The disto-lingual is represented only in the distal marginal ridge, or may be entirely absent when the oblique ridge forms the posterior margin of the surface. The buccal cusps are like in form to those of the first and second molars except that they are shorter and smaller. The mesio-lingual cusp is large and rounded and the central fossa is well defined; usually many small ridges descend from the cusps into it. The mesial marginal ridge is well defined, the buccal depends in character upon the buccal cusps and the lingual is usually poorly discernible. The posterior margin may be either formed by the triangular ridge or the distal marginal ridge may be present.

The Buccal Surface (Fig. 67).—In typical teeth this resembles the buccal face of the second molar but is smaller in extent, more rounded, and its distal lobe is poorly defined.

The Lingual Surface (Fig. 68).—Variations in the form of this surface are caused by the presence or absence of the disto-lingual cusp—when present, this cusp surmounts a lobe of this surface which is partially divided

Fig. 66.—Left Upper Third Molar. Occlusal Surface.

Fig. 67.—Left Upper Third Molar. Buccal Surface.

from the mesial lobe by the disto-lingual groove. In this event the mesial lobe resembles that of the second molar but is even more convex. When the lingual side is surmounted only by one cusp, it is much rounded and convex and joins the mesial and distal faces almost without line of demarcation.

Fig. 68.—Left Upper Third Molar. Lingual Surface.

Fig. 69.—Left Upper Third Molar. Mesial Surface.

The Mesial Surface (Fig. 69).—This resembles that of the second molar in being flat and sometimes concave from buccal to lingual sides, but it is smaller in extent of surface.

The Distal Surface (Fig. 70).—While it is usually rounded from buccal to lingual side, being always so when the disto-lingual cusp is absent, this surface may also be flat or even concave, when the crown has four cusps. It is always smaller in area than the mesial surface or than the distal surface of the first and second molars.

The Roots.—These vary much even in teeth which are typical in regard to their crowns. There are sometimes three roots, a mesio-buccal, a disto-buccal and a lingual, which are usually short and have a distal and a lingual curvature. These are sometimes fused together throughout most of their length. Occasionally only one root is seen caused by the complete fusion of the roots. Occasionally also four roots may be found (Fig. 71).

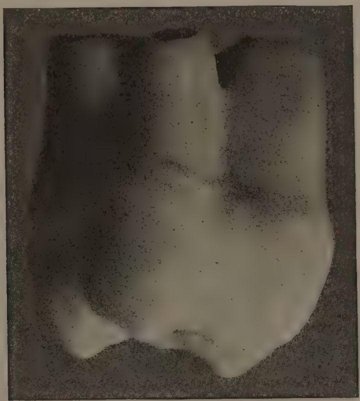


Fig. 70.—Left Upper Third Molar. Distal Surface.

Fig. 71.—Left Upper Third Molar With roots not completely developed and atypical in having four roots. Showing large patulous openings into root canals.

The Pulp Cavity.—The external form of the crown largely determines the form of the pulp cavity, so that in trituberculate teeth this cavity is triangular in cross-section while in quadrituberculate teeth, it has the general form of the pulp chamber of the other upper molars. Its lateral walls converge more to the floor of the pulp chamber which is situated at a higher level than that of the pulp chamber of the second molar. The horns of the pulp chamber are less well defined and are shorter than those of the other upper molars and correspond in number to the number of cusps in any given tooth. The pulp canals usually correspond in number with the number of roots except that in teeth in which the roots have fused into a single one, there may be three or even four root canals, which sometimes have separate apical foramina, or again may unite before this is reached and have a common termination. Occasionally in the single rooted tooth

there is only one large canal, the walls of which are continuous with those of the pulp chamber and converge to a small foramen at the root apex. Where more than one canal exists, they are small and thread-like, quite short as the roots are short, and the openings from the pulp chamber into them are very close together.

THE LOWER FIRST MOLAR

The largest tooth of the human series is the lower first molar, which is longer mesio-distally than the upper first molar, and is of about equal width. The five surfaces of its crown may be described.

The Occlusal Surface (Fig. 72).—This is irregularly trapezoidal in outline, its four margins usually being rounded. The buccal and lingual are more convex than the mesial and distal which may be almost straight. These latter converge toward the lingual side in consequence of which this is shorter than the buccal. Five cusps are usually present, three upon the buccal side and two upon the lingual. A central fossa is formed and occupies nearly the center of the surface and from this radiate grooves separating the cusps. Four ridges bound the surface. The mesial marginal ridge is the best defined of these. It passes from the mesio-buccal to the mesio-lingual angle of the crown, is concave rootward and is usually crossed near its center by the mesial groove. It is continuous at its buccal and lingual extremities with the marginal ridges of these names. The buccal marginal ridge is poorly defined, is bowed in a buccal direction, and is made up of the ridges descending mesially and distally from the three buccal cusps. The distal marginal ridge is not so prominent as the mesial but is like it in other respects. It is commonly crossed by the distal groove. The lingual marginal ridge is made up of the ridges descending anteriorly and posteriorly from the two lingual cusps. It is cut near its center by the lingual groove and is somewhat sharper than the buccal marginal ridge.

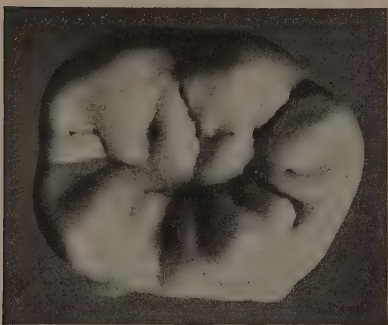


FIG. 72.—Right Lower First Molar. Occlusal Surface.

The mesio-buccal cusp is usually the largest and sometimes the longest cusp of this tooth. It is a rounded elevation with ridges descending mesially, bucally, and distally, and sometimes two or more toward the central fossa from its lingual sides. The names of these ridges correspond to the direction in which they descend from the point of the cusp, except that

the lingual ridge is usually spoken of as the triangular. It is the most sharply defined of all.

The buccal cusp is next in size of the buccal series of cusps, being intermediate in size and position between the mesio-buccal and the disto-buccal cusp. It has also four ridges which pass in a buccal, lingual, mesial and distal direction respectively. The lingual ridge descends into the central fossa and is called the triangular ridge. The disto-buccal cusp is separated from the last described cusp by the disto-buccal groove. It varies in size and position. It is more prominent buccally where it is of greatest size, but when found of small size it is located nearer the distal face of the tooth and there is a corresponding increase in the size of the buccal cusp.

The disto-buccal is always the smallest cusp. Three ridges, a mesial a distal and a triangular, may usually be observed, but its buccal surface is rounded and convex.

The lingual cusps are sharper than the buccal cusps. The mesio-lingual is sharp and prominent in the unworn tooth and its summit is near the mesio-lingual angle. Its lingual surface is continuous with that of the crown but ridges descend mesially, distally, and buccally. The triangular ridge passes into the central fossa and terminates at the mesial groove opposite the triangular ridge from the mesio-buccal cusp. These two ridges are separated from the mesial marginal ridge by a shallow depression running bucco-lingually. The disto-lingual cusp is usually smaller than the mesio-lingual, but like it, is pointed and has three ridges descending from its summit, and otherwise resembles it in shape.

The central fossa occupies approximately the center of the occlusal surface, and is broad and shallow. The mesial and distal marginal ridges and the five cusps contribute to form its walls. The mesial groove passes from it to the mesial surface, the buccal groove is well marked, usually the seat of a fissure, and passes buccally between the mesio-buccal and buccal cusps; the disto-buccal groove, also frequently the seat of a fissure, passes between the buccal and disto-buccal cusps; the distal groove crosses the disto-marginal ridge and the lingual groove passes between the lingual cusps, although in some instances it is very poorly marked. The floor of the central fossa is flat and frequently small tubercles of enamel are found divided from each other by fine grooves. The central pit, a fault in the enamel, is usually found where the buccal and lingual grooves meet and a distal pit often at the occlusal termination of the disto-buccal groove.

The Buccal Surface (Fig. 73).—This is trapezoidal in shape, and is convex mesio-distally and occluso-gingivally. The mesial and distal

margins are much rounded and ill defined, the occlusal margin is marked by three elevations, the cusps, and two grooves, and the cervical is usually convex rootward and marked with a prominent ridge of enamel, the cervical ridge. The buccal groove crosses the surface a little mesial to its center and, decreasing in depth, is continuous with the depression caused by the bifurcation of the roots, or it terminates half way between the occlusal and cervical margin in a well-defined depression, the buccal pit.

FIG. 73.—Right Lower First Molar. Buccal Surface.

FIG. 74.—Right Lower First Molar. Lingual Surface.

The disto-lingual groove is less deep at the occlusal margin and terminates by disappearing about half way from the cervix. These grooves divide the buccal surface into lobes of which the mesial is most strongly marked, the central and distal being more rounded and usually uniting at the cervical portion, being separated at their occlusal portion by the disto-buccal groove.

The Lingual Surface (Fig. 74).—This is convex in all directions but is less so occluso-gingivally than the buccal because of the sharpness of the lingual cusps. Its mesial and distal margins are much rounded and converge to the cervical which is convex rootward. The occlusal margin is marked by the two cusps and the lingual groove. The latter is often poorly marked although it is occasionally deep but usually disappears

about the center of the surface, and the division of this surface by it into two lobes is not usually distinct.

The Mesial Surface (Fig. 75).—While it is generally convex and usually so near the occlusal margin where it affords a point of contact with the second bicuspid, this surface is sometimes flat and usually a concavity may be noted near the cervical line. The occlusal margin is notched by the mesial groove between the two mesial cusps, the lateral margins are rounded and convex in an occlusal direction.

FIG. 75.—Right Lower First Molar. Mesial Surface.

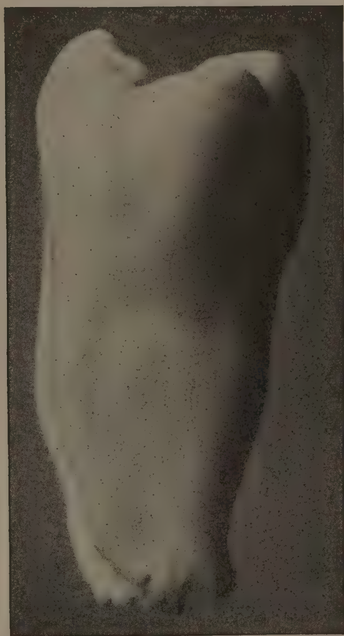


FIG. 76.—Right Lower First Molar. Distal Surface.

The Distal Surface (Fig. 76).—This resembles the mesial face of the crown in outline, but is more convex. Its cervical and lingual margins are like those of the mesial but the varying size and position of the disto-buccal cusp determine the occlusal and buccal margins. The latter is rounded and the former is marked by the distal groove. These unite at the disto-buccal cusp, the position of which determines whether the occlusal margin is long or short.

The Roots.—There are two roots (Fig. 73), named from their positions, mesial and distal. They are both broad and much flattened mesio-distally. The point of bifurcation is about one-fourth the distance from the cervix to the root apices. The mesial root when viewed from the mesial surface

(Fig. 75) is seen to be flat, its sides converging but slightly to a blunt apex. On both its mesial and distal surfaces a longitudinal depression running the length of the root may be observed. The mesial and distal sides are nearly parallel until the apex is reached. The root is curved mesially so that its lower third has a decided distal turn. The distal root is usually straight and is flattened also mesio-distally. It is not marked by longitudinal depressions on its mesial and distal sides, terminates in a sharper apex than the mesial root, and is not so long.

The Pulp Cavity.—The chamber corresponds in general to the shape of the crown, being quadrilateral in horizontal cross-section (Fig. 77). The occlusal wall of the chamber in young teeth has five horns which are in relation with the five cusps, but these are very poorly marked because of the shortness of the cusps. The lateral walls are four in number, the buccal wall being of greatest extent. These converge to the floor

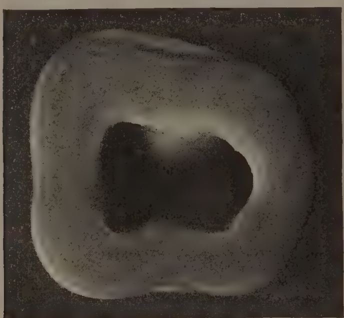


Fig. 77.—Right Lower First Molar. Cross-section at cervix, showing the pulp chamber and entrances to the pulp canals.

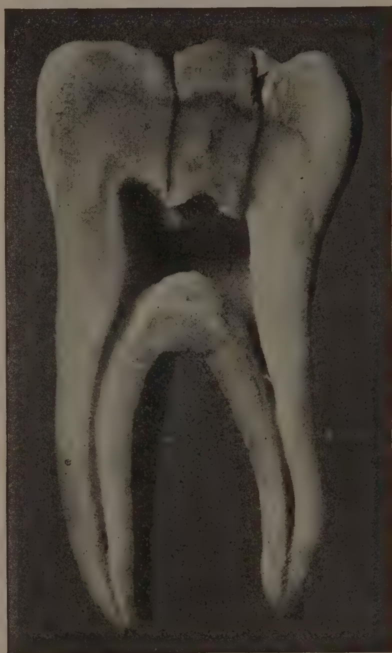


Fig. 78.—Left Lower First Molar. Mesio-distal longitudinal section cut through the buccal cusps and the pulp canals, showing pulp chamber and canals.

(Fig. 77) which is concave bucco-lingually and convex mesio-distally. The buccal and lingual walls meet in a trough-like depression which dips down anteriorly and posteriorly to the entrance into the pulp canals. In any but old teeth the mesial and distal walls (Fig. 78) are continuous with the walls of the pulp canals. The openings to the latter are funnel-like. There are usually two canals in the mesial root which are fine and thread-like and round. They occasionally meet before the apex of the root is reached and terminate in a common foramen although they usually

make exit by separate foramina. The distal pulp canal is larger and ovoid in cross-section and easily entered.

THE LOWER SECOND MOLAR

The crown of the lower second molar differs from that of the first in that it has four cusps of nearly equal size instead of five. In other particulars its surface form is very similar.

The Occlusal Surface (Fig. 79).—The occlusal surface presents for examination four cusps of nearly equal size, situated near its four angles. The summits of the cusps are nearer the center of the crown than are those of the first molar and are more rounded. The outline of this surface is more rounded than that of the first molar, the mesial and distal margins being of equal length and convex. The buccal and lingual are also usually of equal length but in some instances that of the former is greater. The mesial and distal marginal ridges are similar to those of the first molar, and the surface has a central fossa from which a mesial, distal, buccal, and lingual groove pass to these respective borders. The central fossa is well defined but shallower than that of the first molar. The triangular ridges from the cusps are well marked and between these the grooves meet forming a cruciform sulcus. Occasionally the tooth has five cusps when the anatomy of this surface is similar to that of the first molar.

Fig. 79.—Right Lower Second Molar. Occlusal Surface.

The Buccal Surface (Fig. 80).—This has the same general form of that of the first molar, but is less complicated because of the absence of the fifth cusp. It is more convex than that of the first molar, is relatively smaller in extent and is not so definitely divided into lobes by the buccal groove. This latter usually terminates by blending with the buccal surface about its center and rarely terminates in a buccal pit.

The Lingual Surface (Fig. 81).—Except that it is smaller, this resembles the lingual face of the first molar crown so closely as to require no separate description.

The Mesial Surface (Fig. 82).—This is more convex than that of the first molar but is like it in other respect.

The Distal Surface (Fig. 83).—The absence of the fifth cusp is responsible for the dissimilarity between this and the distal surface of the first molar.

FIG. 80.—Right Lower Second Molar. Buccal Surface.

FIG. 81.—Right Lower Second Molar. Lingual Surface.

FIG. 82.—Right Lower Second Molar. Mesial Surface.

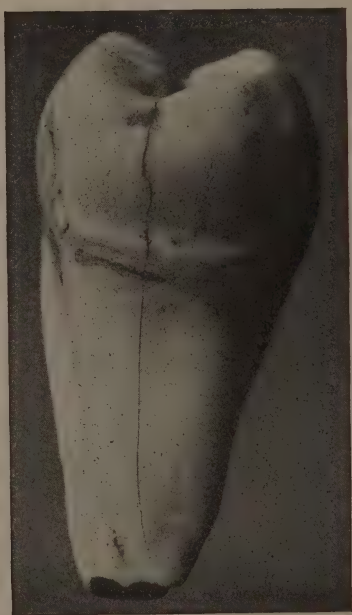


FIG. 83.—Right Lower Second Molar. Distal Surface.

It resembles, however, the mesial surface of the second molar, being slightly more rounded.

The Roots.—These are two in number and closely resemble the roots of the first molar. They are not quite so long, do not exhibit the longitudinal depressions seen upon the roots of the first molar, terminate in sharper apices and are usually inclined to the distal at their extremities.

The Pulp Cavity (Fig. 84).—The occlusal wall of the pulp chamber has only four rudimentary horns, the floor of the chamber is smaller and the openings into the pulp canals are closer together but in other particulars this is similar to the chamber of the first molar.

FIG. 84.—Left Lower Second Molar. The roots have not been completely developed. Longitudinal section through mesial root showing pulp cavity and method of its division into two pulp canals.

THE LOWER THIRD MOLAR

No tooth in the human denture is subject to greater variation than the lower third molar. The form most commonly found is that with four cusps, in which instance the crown much resembles the second molar. Rarely it is possessed of five cusps, being somewhat similar to the first molar in form. Often its occlusal surface is much broken up and exhibits a fossa surrounded by a number of cusps and is nearly circular in outline.

The Surfaces.—When four cusps are present, and this is the commonest form, the occlusal surface resembles that of the second molar except that the cusps are shorter, the fossa is shallower and the outlines of the surface are more rounded. When several cusps exist the grooves separating them radiate from the central fossa. The buccal, lingual, mesial and distal surfaces resemble those of the second molar if the tooth has four cusps, or those of the first if it has five. In other forms of the tooth the tendency to roundness of these surfaces is to be noted and it is usually difficult to perceive any line of demarcation between them.

The Roots.—There are two which usually resemble the other lower molar roots except that they are shorter in proportion to the size of the crown, and generally have a marked distal curve which complicates the extraction of the tooth. Often the roots are fused and sometimes throughout their whole extent, giving thus only one actual root.

The Pulp Cavity.—It can only be said concerning this that the chamber corresponds to the external form of the crown, being similar to this

cavity of the first or second molar according as the crown resembles one or the other of these teeth. In other instances it is usually a rounded cavity resembling the external form of the crown. The pulp canals are similar in number to those of the first molar and may be found separated even if the roots of the tooth are fused. In rare instances a single large canal terminating in a single small apex is found.

THE INTERPROXIMAL SPACES

The relationships of the various portions of the incisal and occlusal surfaces of the teeth in the occlusal position of the mandible are described in the chapter on Orthodontia to which the reader is referred for details. Figs. 85 and 86 illustrate the teeth in occlusion. Examination of these figures will show that each tooth is also in contact with the teeth which adjoin it on either side at a point about one-third the distance from the incisal or occlusal surface to the gingival margin. This is spoken of as the "point of proximal contact." It will be observed that a triangular space exists between this point and the margin of the alveolus, which is known as the interproximal space. In the young subject this space is almost wholly filled with the soft tissue of the gum which extends nearly up to the proximal contact points, but as age advances the sharply defined margin of the alveolus becomes blunted and the gum tissue recedes so that in late adult life this space is normally more incompletely filled. The normal proximal contact of the human teeth (man being the only animal with no diastema in the denture) protects the gum tissue between the teeth and the adjoining gingival attachment from injury during the mastication of hard food. Wherever caries has destroyed this proximal contact or where it is wanting from other cause there is danger of wounding the gum and pericementum in the proximal space by the wedging of food of a fibrous character between the teeth, with the subsequent formation of pockets between the free margin of the gum and the tooth root. The food wedged into this space can only be removed by some mechanical means and the difficulty increases as time goes on. If allowed to remain its fermentation is attended with the added chemical and bacterial irritation of the tissues and the carious process is further favored. From these facts will be easily seen the necessity for the present practice in operative dentistry or in crown and bridgework for a complete reëstablishment of the proximal contact points in all such restorative procedures.

THE DECIDUOUS TEETH

The temporary or deciduous teeth serve for purposes of mastication during the earlier years of life and are exfoliated between the fifth and the twelfth years to give way to their permanent successors. They are less

highly developed for functional purposes than the permanent teeth but entirely satisfy the requirements of the food habit of these early years. They are necessarily smaller than the permanent teeth and are but twenty in number.

They resemble in many respects the permanent teeth as regards external form and internal anatomy, but differ in some particulars and these latter must be pointed out. They are in general less well developed as to surface markings. They have relatively longer roots but these

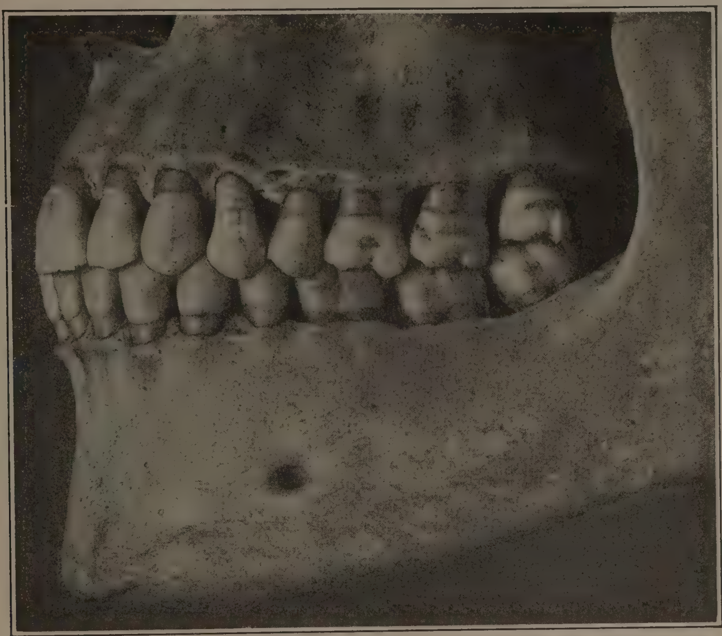


FIG. 85.—The permanent teeth in occlusion. External view. (American Text-book of Prosthetic Dentistry.)

are relatively smaller than those of the permanent teeth. This latter fact accounts for the constricted neck and bell-shaped crown characteristic of the deciduous teeth. The crowns of the teeth are shorter in relation to their width than are those of the permanent teeth.

The Upper Central Incisor (Fig. 89).—In addition to being much smaller than the permanent central incisor, the crown of this tooth is less well marked upon its surface. The labial grooves, the lingual marginal ridge and fossa and the distal angle are especially lacking in development. Its surfaces are much rounded and its neck is constricted. The root is relatively longer and smaller than that of the permanent tooth but resembles it in other particulars.

The Upper Lateral Incisor (Fig. 89).—This resembles both the permanent lateral and the deciduous central incisor. It has the characteristics of the former except in a modified degree. Its surface markings are less pronounced than are those of the permanent lateral and it resembles the deciduous central except that its width is less and its distal angle is more rounded. It is a more delicately shaped tooth but is usually equal in the length of its crown to the central and frequently its root is longer. The latter resembles that of the permanent lateral incisor in other particulars except of course that it is relatively smaller.

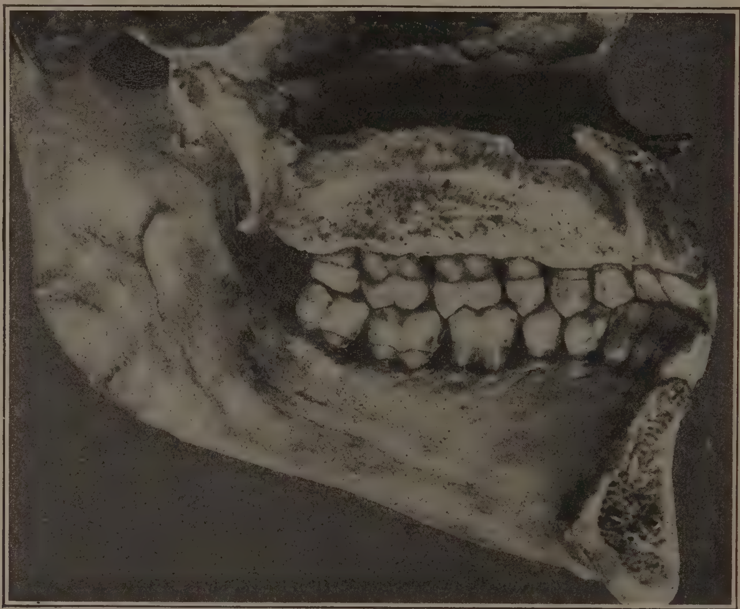


FIG. 86.—The occlusion of the teeth. Lingual view.
(American Text-book of Prosthetic Dentistry.)

The Upper Cuspid (Fig. 89).—The resemblance between this tooth and that of the permanent series is marked, but sufficient differences exist between them to easily differentiate the two teeth.

The crown of this tooth is proportionately shorter and more rounded than that of the permanent cuspid. The labial surface presents a marked labial ridge ascending from the point of the cusp, and the labial grooves are much nearer the angles of the tooth. The angles of the crown are much nearer the cervical line than those of the permanent cuspid in consequence of which the mesial and distal cutting edges are relatively longer and the mesial and distal surfaces are smaller. The lingual surface has a marked lingual ridge and the surface is generally rounded and convex. The root is proportionately smaller than that of the permanent cuspid and

the pulp canal is small in consequence, but the pulp chamber, like that of all the deciduous teeth, is relatively large.

The Upper First Molar.—The molar teeth of the deciduous series are totally unlike their successors, the bicuspids, and partake chiefly of the characteristics of true molar teeth. The crown of the first upper molar usually has three cusps, two on the buccal and one on the lingual side. (Fig. 87.) The surface is almost quadrilateral because the large size of the lingual cusp serves to balance the two buccal on the opposite side. The corners of the figure are much rounded, the sharpest corner being the mesio-buccal while both the lingual corners are much rounded. The buccal cusps are sharper than the lingual which is full and rounded, although all are more pointed than those of the upper permanent molars. A central fossa occupies the space between the cusps. It is broad and shallow. A groove passes from it to the buccal, mesial and distal sides respectively, and these serve to separate the cusps from each other.

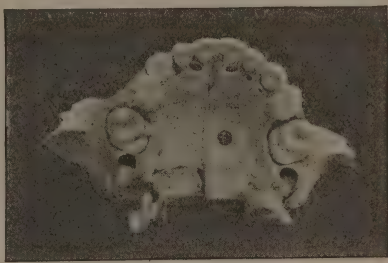


Fig. 87.—Occlusal surface of the upper deciduous teeth.

The buccal surface resembles that of the upper molars except that the occlusal margin is sharp, the surface is more rounded, the buccal groove is very shallow and poorly defined, and at the cervical margin a ridge of enamel passes from the mesial to the distal border. The lobe of this surface mesial to the buccal groove is proportionately larger than that of the permanent molar, as it is both wider and larger from occlusal to cervical margin than the distal lobe.

The lingual surface is full and convex in every direction and passes into the mesial and distal faces without demarcation. These latter resemble those of the upper permanent molars, the mesial, being flattened with a convexity near the occlusal margin, the distal being rounded.

Three roots are possessed by this tooth. They are mesio-buccal, disto-buccal and lingual. The buccal roots are flattened mesio-distally, the lingual being flattened bucco-lingually, and they diverge markedly in order to give a space for the permanent tooth which succeeds and which occupies for a time the space between the roots.

The pulp chamber is rounded and large, corresponding with the general external form of the crown. The root canals are small and thread-like and difficult to enter.

The Upper Second Molar (Fig. 89).—This tooth is larger than the first temporary molar and resembles the first permanent molar so exactly that a

separate description is unnecessary. It seldom has the lingual cingule or fifth cusp, it is smaller, more constricted at the neck and its roots are widely separated at their apices, but in other particulars the description of the permanent tooth will suffice.

The Lower Central Incisor.—Except for the fact that the tooth is smaller, has more rounded angles, and has its labial and lingual grooves poorly defined, the description of the permanent tooth would equally apply to this. It must be added, however, that its root is relatively smaller than that of its successor.

Fig. 88.—Skull showing deciduous teeth in occlusion.

The Lower Lateral Incisor.—The resemblance between this and the upper deciduous lateral incisor is marked. It is wider than the lower central and its distal angle is rounded like that of the upper lateral. Its various surfaces and its root are like those of its upper opponent and further description is unnecessary.

The Lower Cuspid.—The upper and lower deciduous cuspids are much alike. The latter is narrower mesio-distally and its surfaces are not quite so convex but in other particulars its anatomy is identical with that of the former.

The Lower First Molar (Fig. 89).—This tooth has the general molar form but a detailed description is necessary for its identification. Its crown is a much rounded cuboid and exhibits four cusps, one near each of its rounded angles. On the occlusal surface these four cusps are seen to be divided by grooves which unite in the fossæ. The mesio-buccal cusp is the largest. A ridge descending from it anteriorly curves and

meets one from the mesio-lingual cusp to form a mesial marginal ridge. Triangular ridges from these two cusps meet at the bottom of a mesial groove, and a small depression is formed between these and the mesial marginal ridge. This is often called the mesial fossa but is very small as compared to the distal fossa which is located between the two distal cusps and these triangular ridges.

A distal, a buccal and a lingual groove, all poorly defined, emanate from the distal fossa in these several directions. The buccal and lingual grooves are not continuous because the greater size of the mesio-buccal cusp

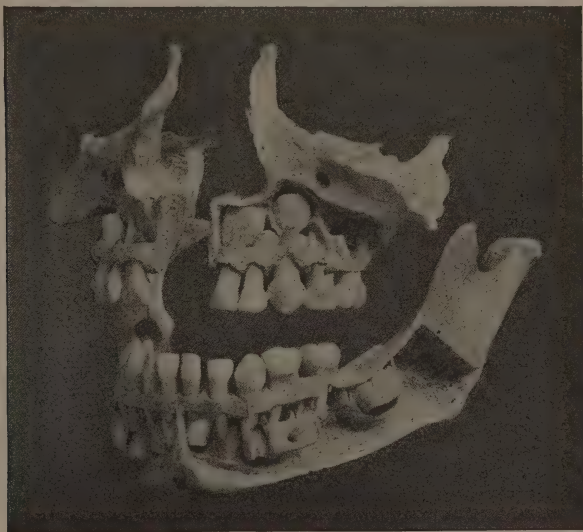


Fig. 89.—Dissected specimen of maxillæ and mandible showing the deciduous teeth.

carries the former too far distally. The disto-buccal cusp is small, the mesio-lingual is usually the sharpest and longest, and the disto-lingual is not well defined as the lingual groove is always shallow. The distal marginal ridge is cut by the distal groove.

The buccal surface is convex and has near its cervical margin a pronounced ridge of enamel, the cervical ridge. The mesial margin is longer than the distal in consequence of the greater size and length of the mesial lobe, a condition similar to that of the first upper deciduous molar. The buccal groove is shallow and either terminates in a pit or disappears upon the center of the surface.

The lingual surface is convex, and the lingual groove marks its occlusal portion about the center when it is present but often it is almost indistinguishable on this surface. The mesial and distal surfaces are very similar to those of the second permanent molar. The mesial is flat with a pro-

nounced occlusal edge; the distal is more rounded and the distal groove usually marks decisively its occlusal margin. The tooth has two roots which are similar to those of the first permanent molar except that they are smaller and quite divergent to give space for the bicuspid which follows. The pulp chamber corresponds in shape with the external surface of the crown. The entrances to the three canals are near together, the two mesial ones being small and very difficult to enter, the distal canal being more accessible.

The Lower Second Molar (Fig. 89).—Besides the constriction of its neck, the divergence of its roots, and its smaller size, this tooth resembles the first permanent molar in almost every particular. The description of the latter tooth will apply to the deciduous tooth and the reader is referred to it.

CHAPTER II

THE HISTOLOGY OF THE HUMAN TEETH

BY CHARLES R. TURNER, D. D. S., M. D.

A knowledge of the minute anatomy of the tissues of the human teeth is as important as an acquaintance with their surface forms, for it paves the way to an understanding of their several physiological relationships in the tooth, to a knowledge of the pathological conditions arising in them, and to a rational conception of the various operative and therapeutic measures used in the treatment of these conditions.

The tissues of the human tooth are the enamel, which is the hard external covering of the crown; the dentin, which composes the bulk of the tooth and largely determines its form; the cementum, which forms the external covering of the root and to which is attached the pericementum, a membrane intervening between the tooth and its bony socket in the alveolar process; and finally the dental pulp, a mass of soft tissue occupying the internal chamber of the tooth called the pulp-cavity.

A clearer understanding of the relationships of these tissues may be had if we first become acquainted with the method of their development in the embryo. This also confers a better knowledge of their structure.

About the fortieth to the forty-fifth day of intra-uterine life, there is a thickening of the stratum Malpighii of the oral epithelium over the site of the future jaw. This forms a band of epithelial cells extending from one end to the other in each jaw. About the forty-eighth day a budding is seen to take place from the under surface of this *tooth-band*, and ten rounded buds appear attached to it, marking the beginning of the tooth-germs for the deciduous teeth. These buds dip further into the substance of the underlying connective tissue, and becoming invaginated upon their advancing surfaces, finally enclose in this invagination a mass of mesoblastic connective tissue and become the tooth-germs. This epithelial cup which has descended from the mucous membrane remains connected with it for some time by a cord of epithelial cells, *the epithelial cord*, but this cord soon disappears, and the tooth-germ is enclosed by a

fibrous membrane developed from the surrounding tissue. The epithelial cup becomes *the enamel organ* of the future tooth, the connective tissue enclosed by it becomes *the dentin organ or papilla.* The whole tooth-germ enclosed in its sac is known as *the dental follicle.* (Fig. 90.)

The enamel organ takes on the form peculiar to the tooth which it is to assist in forming, and its cells begin to alter in character. Those

Fig. 90.—Section of upper jaw of human embryo near the seventh month of fetal life, showing development of temporary cuspid. A. Ameloblasts showing beginning of enamel formation. B. Dentin. C. Showing beginning of dentin formation. D. Walls of tooth sac, E. Dentinal papilla. ×50. (Williams. *Dental Cosmos.*)

next to the dentinal papilla become columnar in form, those on the exterior disappear by atrophy, while the intervening ones are changed from polygonal to stellate cells and become *the stellate reticulum.* This latter finally almost entirely disappears, leaving however next to the inner columnar layer a small layer of cells which now comes to be known as *the stratum intermedium.* The inner columnar cells now become enlarged and elongated, their nuclei move to their outer ends and they become *the ameloblasts*, which are the cells directly concerned with the formation of the enamel.

The dentin organ or papilla which occupies the space within the enamel organ, and which is formed from the mesoblastic connective tissue, is composed of embryonal connective tissue cells of various kinds; spindle shaped, round, and stellate cells are scattered through its substance, while over its entire periphery there is a layer of specialized club-shaped cells, *the odontoblasts*, which are specifically concerned in the formation of the dentin.

In the development of the tooth, a deposit of dentin initiates the process, a layer of dentin being calcified about the external surface of the odontoblastic layer of the papilla. The function of the odontoblasts in this process is imperfectly made out. It is known that lime salts are deposited about their external processes and that these latter become the dentinal fibrils. Furthermore, as said by Broomell, they are believed to superintend the dentin formation, but just what is their relation to the deposition of the lime salts is not known. After the dentin cap is begun it grows by additions to its interior, while upon its periphery enamel formation begins. This is by a process of secretion in which globular masses of calco-globulin are formed in the ameloblastic cells; these escape from the external ends of the ameloblasts and, becoming packed together one after another, form the enamel prisms. An albumen-like substance, according to Williams, is secreted in the stratum intermedium, and flows about the partially formed prisms, "supplying the cement substance and probably the mineral matter for the calcification of the whole."

Cementum is formed upon the completed dentin root of the tooth by specialized odontoblastic cells, *the cementoblasts*, which have developed in the wall of the tooth follicle. Its growth is similar to that of subperiosteal bone.

The pulp is what remains of the dentin papilla, after the latter has been reduced in size by the growth of the dentin walls. The peripheral layer of odontoblasts persists during the life of the pulp, but after the mature tooth is formed, these cells remain inactive unless called into activity by some pathologic stimulation from without.

THE ENAMEL

The enamel constitutes the external covering of the crowns of the teeth. It is by far the hardest of the animal tissues and for this reason it is particularly suited to resist the wear incident to the use of the teeth in the comminution of food. Its distribution over the crown of a tooth is not uniform, as it is thinnest at the cervical margin, where it is slightly overlapped by the cementum; from this margin it increases in thickness,

until over the cusps and cutting edges of the teeth, where it is most exposed to wear, it is thickest of all. It is also slightly thicker at the site of the elevations and ridges upon the crowns of the teeth. In the newly erupted tooth it is faintly and delicately ridged transversely, and in some teeth it presents other evidences of its development, but it soon wears smooth and lustrous. When a tooth is erupted the enamel is entirely completed over the whole of its crown. No portion of the tooth is erupted until the enamel covering it is fully formed. When once formed enamel is a fully completed substance, and no physiologic change in its structure or composition ever occurs thereafter. Williams remarks, "Enamel is a solid mineral substance, and the finest lenses reveal not the slightest differences between enamel ground moist from a living tooth, and that which has laid in the earth for a hundred centuries.

Defects in the structure of the enamel, in consequence of which the value of its protective office is lessened, are commonly observed at the site of the fissures and pits upon the surface of the tooth-crown which marks the points of union of the several centers from which calcification began. These faults are frequently found in the sulci of the molar and bicuspid teeth, in the buccal pits of the molar teeth, and in the lingual fossæ of the upper lateral incisors. These defects are favorable sites for the beginning of caries, the break in the integrity of the enamel affording lodgment for the bacteria and a favorable starting point for their activity.

While enamel is formed in an organic matrix, not the least trace of this remains chemically in the completed enamel. This accounts for the lack of sensitivity of this structure, for it is not capable of transmitting physiologically any sensations whatever. These facts demonstrate its value as a vital protective covering for the teeth.

Chemically it consists chiefly of the phosphate and carbonate of calcium as the following analysis by von Bibra shows:

	Man	Woman
Calcium phosphate and fluorid	89.82	81.63
Calcium carbonate	4.37	8.88
Magnesium phosphate	1.34	3.55
Other salts	.88	.97
Cartilage	3.39	5.97
Fat	.20	a trace
Organic	3.59	5.97
Inorganic	96.41	94.03

Charles Tomes has shown that the organic matter obtained in this and the older analyses is simply the water which is combined with the lime salts. He has proven that it will be suddenly given off upon ignition of the specimen under analysis.

Enamel is not a homogeneous mass of calcified tissue but, under the microscope may be seen to consist of a collection of prisms or rods, five and six sided, which are united together by means of a cementing substance. (Fig. 91.) As it contains no organic matter whatever and has resulted from the completed calcification of the matrix in which it is formed, we find no chemical remains of the matrix, but the tissue exhibits structural evidences of its mode of formation. Generally speak-

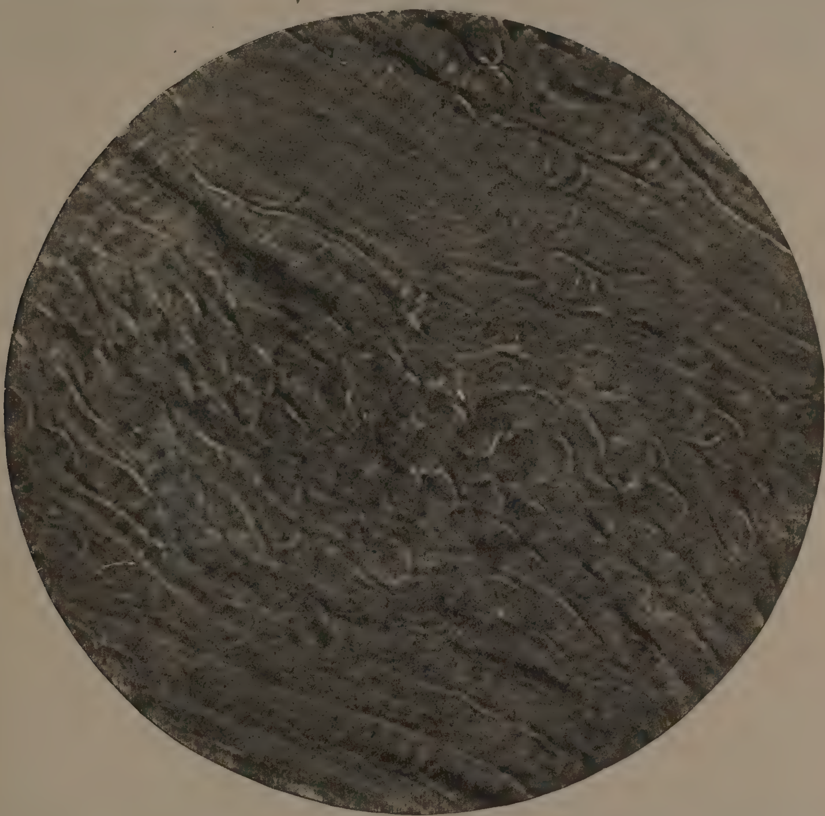


FIG. 91.—Section of enamel of human tooth near line of dentin. Shows enamel rods in cross- and longitudinal-section. × 1000. (Williams. *Dental Cosmos.*)

ing the enamel rods are arranged so that they begin at right angles to the surface of the dentin, from which they extend to the external surface of the tooth. In the cervical region they incline somewhat downward in the direction of the root, but as the lower third of the crown is reached they pass horizontally outward, becoming more inclined occlusally as the cusps and the cutting edges of the teeth are reached, in which positions they are largely parallel to the long axis of the tooth. (Fig. 92.) The ends of the prisms are thus exposed to the wear of these surfaces.

While a majority of the rods extend from dentin to surface, it will be seen that as the surface area of the latter is greater than that of the former, and as the rods are practically of the same diameter at each end, additional rods are required to fill in the interspaces in this fan-like arrangement. These additional rods begin between the other long rods and extend outward toward the surface of the tooth. While the rods pursue in general an almost straight course, in all instances they are slightly curved and in some cases they are much contorted and twisted, and when this is marked the enamel is usually spoken of as "gnarled."

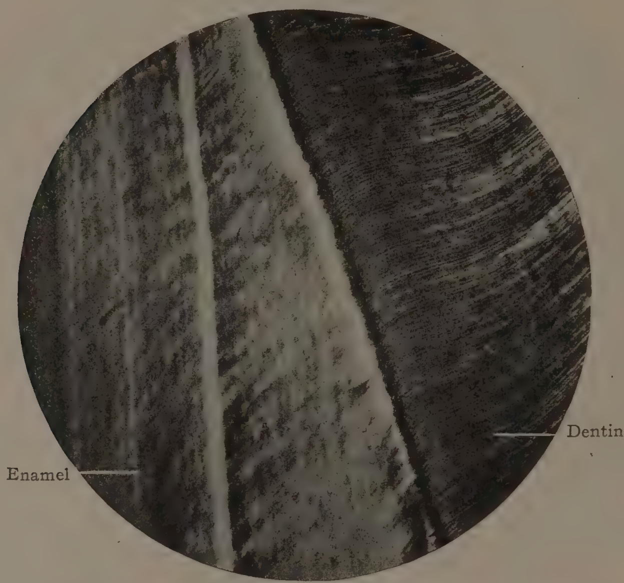


FIG. 92.—Section showing dentino-enamel juncture, the direction of the enamel rods and primary curvatures of dentinal tubules. (Broomell.)

The rods are not of uniform diameter throughout their whole extent, as each rod presents a number of varicosities which increase its size. (Fig. 93.) These varicosities vary in different specimens of enamel but they are present in all. The enlarged portion of one rod is opposite to that of the adjacent rods, and they do not alternate as would seem the more natural arrangement. The reason for this is the fact that the globules, of which the rods are made and which are responsible for the varicosities, were deposited simultaneously. The varicosities do not as a rule appear so pronounced in the enamel next the dentin, but elsewhere in any given specimen they are of about uniform occurrence. The space between the rods is filled in with a more transparent but not more highly calcified cement substance. Williams has shown a specimen in which the

globules composing the rods do not appear continuous but seem united with this cement substance as the rods are united to each other. It is very probable that this is due to the refraction of the light by the rod substance, as longitudinal sections of the rods normally exhibit under the microscope a series of light bands, the so-called "striation" of the rods, which may be brought into view or made to disappear by slightly changing the focus and were formerly believed to have some structural significance.

Another appearance presented by the enamel rods under the microscope is illustrated in Fig. 94. In this it will be seen that bands of darker enamel alternate with those of lighter, thus dividing it into strata. This

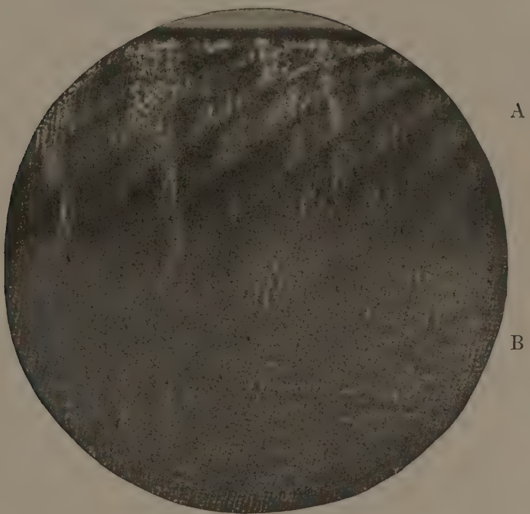


FIG. 93.—Enamel rods showing varicosities and striæ of Retzius: A. Brown striæ of Retzius. B. Enamel rods showing varicosities. × 200. (Williams. *Dental Cosmos.*)

stratification of the enamel is due to the fact that small quantities of pigment have been laid down at various stages in its development, and they simply mark the exterior of the crown at the time they were laid down. They are in reality incremental lines and mark successive stages in the growth of the enamel. They are usually spoken of as the "brown striæ of Retzius." They begin at the summit of the already formed dentin and extend in curves toward the cervix. The addition of more dentin at the developing end of the tooth gives more surface for enamel to be deposited upon, and another stratum of enamel is formed covering the already formed enamel. The enamel formation at the occlusal end of the crown is completed before that at the cervix. These facts explain why the incremental lines are neither parallel to the external surface nor to that of the dentin.

The "lines of Schreger" are another characteristic of fully formed enamel. They are not visible by transmitted light but can be seen by reflected light as Fig. 95 shows. They are said to be due "to the various directions assumed by the contiguous groups of enamel rods."*

The physical characters of enamel, which are interesting from the standpoint of filling operations upon the teeth, are more readily understood when they are viewed in the light of the histology of the tissue. Mature

FIG. 94.—Longitudinal section of human enamel showing globules. Polarized light. × 300. (Williams. *Dental Cosmos.*)

enamel forms a hard covering for the crowns of the teeth which will resist a large amount of force upon it. The enamel rods fit closely together and the intervening tissue is highly calcified and binds them together. Thus they give each other lateral support, and unless there is a break in the enamel surface, it is very difficult to fracture or crush them. In addition, their inner ends rest upon the dentin, a slightly elastic tissue, which gives them a firm support. It is upon these two facts that the ability of the

* Broomell: Anatomy and Histology of Mouth and Teeth, 1902, p. 395.

enamel to resist physical force largely rests. If, however, there is a break in the enamel surface, then it is an easy matter to split off the enamel rods immediately adjacent to the break, and especially is this true if the enamel so split is not supported upon mechanically sound dentin. While the enamel is intrinsically of a high degree of hardness, yet it has a natural cleavage, and the line of this is along the interprismatic substance, so that the line of cleavage is approximately parallel to the direction of the prisms. Occasionally it breaks transversely through a prism here and there, but never along the central axis of the prism. The lesson these facts teach in the preparation of cavities for filling operations is that the enamel at their

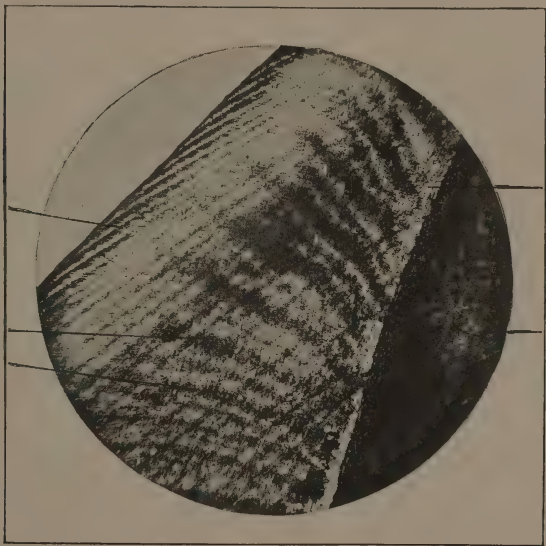


FIG. 95.—Section showing striæ of Retzius or incremental lines of the enamel and the lines of Schreger. (Gysi. Broomell.)

margins must be supported upon dentin, and that these margins must be formed so that no prisms which do not reach the dentin are allowed to remain. This requires that the cavity margins be beveled at the expense of prisms which are firmly seated upon the dentin, and a knowledge of the direction of the enamel prisms is necessary in preparing the cavity margins.

Black* has shown that enamel possesses less strength than the dentin, as to resistance to both tensile and crushing strains. Therefore the retentive portions of cavities should be made in the dentin, and the mechanical force used in the insertion of gold fillings should be slight upon enamel margins. He has also shown that where several thicknesses of gold were placed between the instrument and the enamel, that the crushing effect of impact is greatly reduced.

* The *Dental Cosmos*, Vol. xxxvii, page 414.

THE DENTIN

The dentin composes the bulk of the tooth, and contributes to its form and strength. It surrounds the pulp and protects this from injury, it gives support to the enamel covering the crown, and upon its root portion is deposited the cementum which affords attachment to the retentive tissues of the tooth. Normally no part of it appears upon the external surface of the tooth, and when here present is exposed from some error in the development of the tooth or from some break in the enamel or cementum. It is light yellow in color, although it varies slightly in shade in different specimens, and it has somewhat the appearance of ivory or bone.

Histologically it is a highly developed connective tissue, and consists of a partly calcified organic matrix traversed by a system of tubules, the contents of which is protoplasmic in character. As it is impossible to remove the contents of the tubules no chemical analysis has been obtained of the matrix proper. Von Bibra gives the following as the constituents of a specimen of thoroughly dried dentin:

Organic matter (tooth cartilage),	27.61
Fat,	0.40
Calcium phosphate and fluorid,	66.72
Calcium carbonate,	3.36
Magnesium phosphate,	1.08
Other salts,	0.83

When the tissue is decalcified by the use of strong acids, the remaining organic matrix yields gelatin on boiling, while that portion immediately surrounding the tubules which differs from the body of the matrix in resisting strong acids and alkalies, yields elastin on boiling (Noyes). Opinion differs as to whether this is more highly calcified than the surrounding matrix. Under the microscope it has a different refractive action upon light as the accompanying high-power field shows (Fig. 96). These are known as "*the sheaths of Neumann*," and surround the protoplasmic contents of the tubules.

The matrix itself is practically structureless and homogeneous in character. The tubules traverse it from the pulp-cavity, to the external surface of the dentin. (Fig. 97.) They begin by a funnel-like opening in the pulp-cavity wall, and extend in curves outward to near the surface of the dentin where they usually branch and anastomose freely. They are of practically uniform caliber from beginning to end, and as the external surface-area of the dentin is greater than that at the pulp-cavity, the tubules are closer together at their beginning from the latter than at the external surface, and diverge almost imperceptibly in passing outward.

They exhibit long graceful curves in their course outward. In the crown of the tooth the tubules exhibit what have been designated their *primary and secondary curvatures.* The tubules begin at right angles to the surface of the pulp, and reach the surface of the enamel at a right angle to it. Between these points they present a reversed curve or ogee. The secondary curvatures are perceptible throughout the extent of the tubule and are due to the fact that the tubule has a general spiral direction through the dentin. In the root portions of the teeth the tubules pursue almost a straight course from the pulp to cementum, which in general is perpendicular to the long axis of the tooth. In the apical region they are arranged radially. At or near the external end they branch out and anastomose

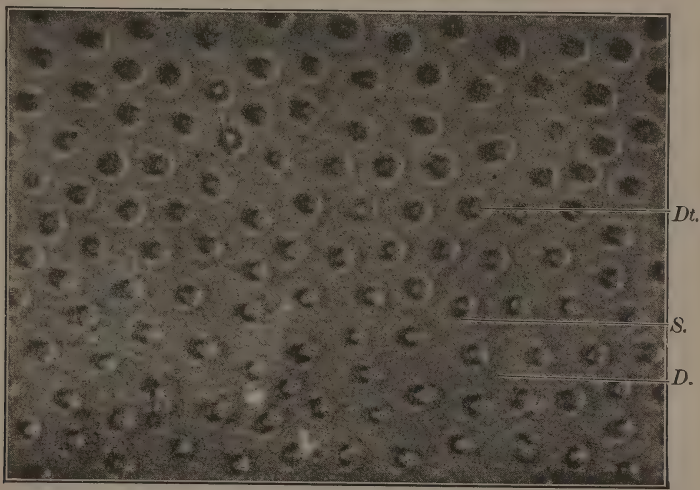


FIG. 96.—Dentin showing tubules in cross-section. Dt. Dentinal tubules. D. Dentin matrix. S. Shadows of sheaths of Neumann. (Noyes. *Amercian Text-book of Operative Dentistry.*)

freely. Inasmuch as it is along the line of the tubules that the infection travels in caries, this arrangement explains how caries may progress along the dentino-enamel juncture and how the enamel is undermined. This also explains the greater sensitivity of the tooth at the dentino-enamel juncture, a clinical fact of common knowledge.

The dentinal tubules contain a protoplasmic mass, the dentinal fibrils, which extend from the odontoblastic layer of cells on the external surface of the pulp. These are usually called *the fibers of Tomes.* Beyond the fact that the fibrils are processes of the odontoblastic cells, nothing yet is definitely known about the manner of their connection with the nerves of the pulp, nor about the way in which sensory impulses are transmitted by them. Unlike the enamel the dentin is a sensitive tissue and has physio-

logic connection with the organism. The dentinal fibrils conduct sensory impulses and it is believed that in some way the dentin is nourished through the contents of the tubuli. One reason for a belief in the latter is the fact as brought out by Black that the dentin of old teeth has a higher percentage of lime salts than that of young teeth. The growth of the dentin is not completed with the eruption of the tooth, for all of its root is not formed at this period, but continues for some time afterward. The root is completed and the pulp becomes reduced in size, successive layers of dentin

FIG. 97.—Transverse section through root of human molar showing the curvature of the dentinal tubules about the pulp canal. ×40. (Broomell.)

encroaching on the pulp-cavity. In the mature tooth the process of dentin formation remains at a standstill until old age, when it will be found that the pulp-cavities are reduced to very small dimensions.

The odontoblasts may be stimulated into activity by irritation from the encroachments of carious cavities or by a wearing away of the tooth substance from abrasion or erosion. Dentin is deposited on the pulp-cavity wall immediately in relation with the site of the irritation and is an expression of a self-protective activity of the pulp. Dentin thus deposited is known as *secondary dentin.* It is of poorer structure than normal dentin and not typical in the arrangement of its tubules, which present many interruptions.

At the dentino-cemental juncture the dentin presents under the low powers a somewhat granular appearance, and this area is known

as *the granular layer of Tomes.* (Fig. 98.) It consists of the so-called *interglobular spaces,* which are erroneously so named as in the fresh specimen they are not spaces but are areas of imperfectly calcified dentin. They are filled with protoplasmic tissue through which the dentinal fibrils may be made out. In the dried specimen they appear as spaces because of the desiccation and contraction of their protoplasmic contents. These so-called interglobular spaces are often found elsewhere scattered through the dentin, usually occupying positions corresponding to a stage in the development of the dentin.

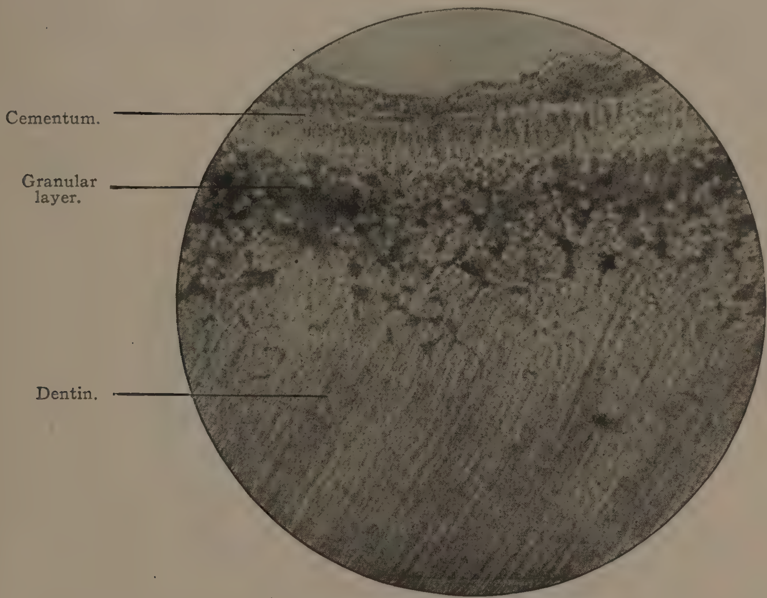


FIG. 98.—Interglobular spaces in the dentin. ×60. (Broomell. *Dental Cosmos.*)

THE CEMENTUM

Histologically considered cementum is very closely related to subperiosteal bone both in its structure and development. Its forms the external covering of the roots of the teeth, serving as a medium of attachment between the pericementum and the dentin. At the cervical margin, it abuts upon the edge of the enamel or slightly overlaps it and at this point is thinly distributed over the surface of the root. It increases in thickness as the apex of the root is reached and the mature tooth is of considerable thickness in this region.

While its structure resembles that of bone in many particulars it differs in having no Haversian system and is easily distinguished from it under the microscope. It presents for examination a *matrix*

of partially calcified organic material containing *lacunæ* and *canaliculi*. The *matrix* or *ground-substance* is similar in structure and composition to that of bone. The lacunæ are spaces scattered through the matrix which are occupied in the recent specimen by *the cement corpuscles*, which are cement-forming cells or cementoblasts which have become encapsulated during the calcification of the tissue. The canaliculi extend from the lacunæ and transmit the processes of the cement corpuscles. Beside these elements the tissue contains the *cement fibers* which are calcified fibers of the pericementum. It is developed by the deposit of successive lamellæ upon the dentin surface and these are visible under the microscope as its incremental lines. The character of the tissue

FIG. 99.—Cementum from cervix of adult tooth. × 40. (Broomell.)

varies with its position upon the root and with the period of tooth development at which it is formed.

The matrix next to the dentin is more nearly homogeneous than elsewhere. Under the microscope it appears somewhat granular and is characterized by the absence of lacunæ and canaliculi. (Fig. 99.) This is also largely true of the whole thickness of the cementum near the cervical margin as lacunæ are infrequent there. The lamellæ making the successive additions to the tissue increase both in number and thickness as the apex of the tooth is approached, and the lacunæ become more abundant in them.

The cement corpuscles which occupy the lacunæ are masses of protoplasmic tissue which are the remains of cementoblasts. They are most abundant in the middle layers of the cementum, are absent in the portion next the dentin, and are infrequent in the outermost layers. (Fig. 100.) Their processes are usually directed toward the outer surface of the tooth, and these occupy the canaliculi above referred to.

Another element of the cementum which is the most variable of its histological constituents is the cement fibers. (Fig. 101.) These, according to Black, are principal fibers of the pericementum which

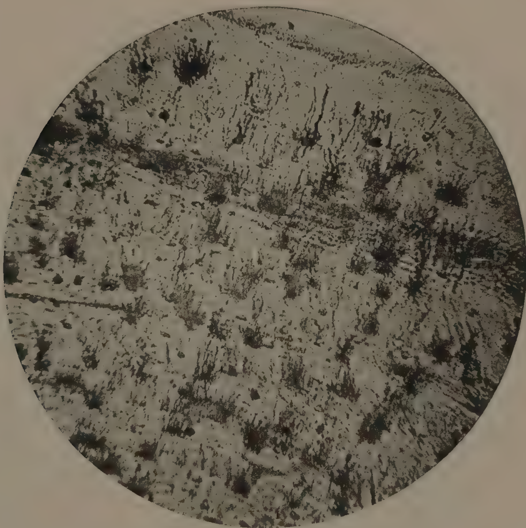


FIG. 100.—Cement corpuscles of the outer strata. × 40. (Broomell.)

have been caught in the developing tissue and calcified. In some rare instances they may be observed to extend from the innermost layer uninterruptedly through to the surface, but they are usually of much shorter extent. Sometimes they correspond in length only to the thickness of one lamella and sometimes to that of two or more. This variation is due to the manner of growth of the cementum and to the fact that the attachment of the pericementum is constantly varying, the fibers being frequently cut off and reattached at different positions. Thus the cement fibers which terminate at the surface of a lamella are those whose attachment has been altered at the completion of the lamella. The fibers are of most frequent occurrence in the apical two-thirds of the tissue and in the central strata of this region. Broomell has called attention to the presence of fibers in bundles in the oldest lamella, the bundles being arranged radially to the long axis of the tooth. The fibers which extend

from the dentin do not have any direct connection with it, but usually terminate here by breaking up into fibers which run more or less parallel to its outer surface. This is to be expected when the method of cemental development is remembered.

In some of the multi-rooted teeth the cementum bridges over the gap from one root to the other, building in the space solidly. Usually some evidence in the way of cement cells or mesoblastic tissue remains to show where the extensions from each root have united. In this type of tissue the lamellæ are poorly marked.

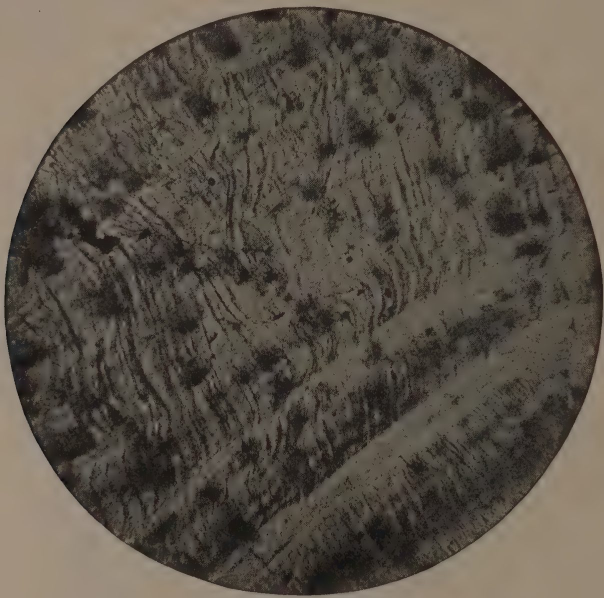


FIG. 101.—Cemental fibers of the middle strata. × 60. (Broomell. *Dental Cosmos.*)

The formation of cementum goes on more or less constantly during life, as cementoblasts are constantly present in the pericementum next to the tooth. In youth the cementum is thin as compared to that found in adult life and in old age.

The cementoblasts are sometimes called into activity after the tooth is formed by some pathological excitant, and this condition is known as a *hyper-cementosis* of the tooth. The tissue thus formed may be of such extent as to complicate the extraction of the tooth, or it may press upon the nerves leading to the pulp or to that of some other tooth and cause obscure pains which are difficult to recognize clinically. The pathologic cementum is usually upon the apical portion of the tooth, and is not typical histologically.

Union occasionally occurs between the roots of different teeth by a fusion of the cementum in a manner somewhat similar to that in which the roots of a tooth unite. This gives rise to the so-called fused teeth which are occasionally found.

THE PULP

The dental pulp consists of the soft tissues occupying the central cavity of the tooth known as the pulp-cavity. It is the somewhat changed remains of the dental papilla, the formative organ of the den-

FIG. 102.—Section of developing tooth of human embryo near seventh month of fetal life. F. Ameloblasts. H. Dentin. I. Odontoblasts. B. and C. Cells of reticulum of enamel organ. D. Stratum intermedium. × 175. (Williams. *Dental Cosmos.*)

tin. It is composed of soft embryonal connective tissue, odontoblastic cells, blood vessels, and nerves. No lymphatics exist in the pulp—a fact of pathologic interest. It has two functions, the formation of the dentin, a function practically quiescent in the adult tooth, and the nutrition and innervation of the dentin.

The odontoblasts, through the medium of which the dentin is formed, are a layer of cells occupying the entire periphery of the pulp and in close relation with the dentin. (Fig. 102.) They exist as a single layer of cylindrical cells during the formative period of the tooth and until late life, when they become rounded or spheroid. They possess three kinds of processes which are usually referred to as *dentinal*, *lateral*, and *pulpal*. The dentinal processes, of which there is only one to an odontoblast (occasionally two may be found), are the dentinal fibrils or fibers

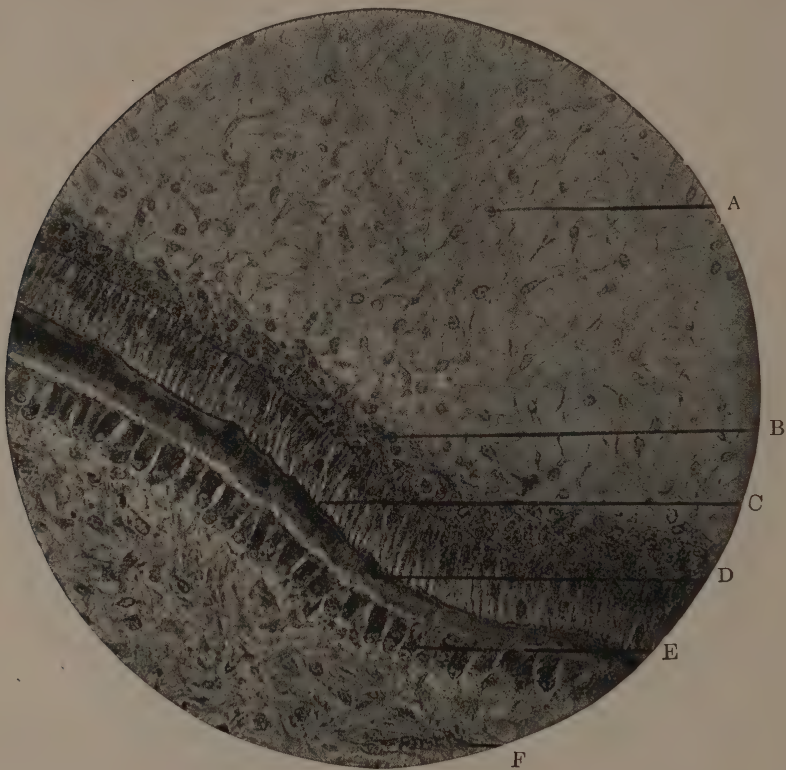


FIG. 103.—Section of developing tooth of embryo calf. A. Stellate reticulum. B. Stratum intermedium. C. Ameloblasts. D. Dentin. E. Odontoblasts. F. Blood vessels with corpuscles in situ. × 275. (Williams. *Dental Cosmos.*)

of Tomes which enter the dentinal tubules; the lateral processes are numerous and by this means the odontoblasts are connected to each other; the pulpal processes extend into the "layer of Weil," a transparent layer of tissue in relation with the pulpal ends of the odontoblasts, and there become lost to view. The odontoblastic cells have large, oval, deep-staining nuclei situated near the pulpal extremity of the cells. This layer of odontoblasts is often called the *membrana eboris*.

The layer of Weil, situated just below the odontoblasts, is a transparent layer of tissue containing very few connective tissue cells, and then below this comes the main body of the pulp tissue. (Fig. 103.) This is composed of connective tissue cells, which may be either stellate or spindle-shaped, with a large mass of intercellular substance, together with a few round cells which Noyes says "are probably young cells which have not yet acquired the adult form."

The blood vessels of the pulp communicate with the general circulation through the apical foramen or foramina of the tooth. One or more small arterial trunks enter the pulp-cavity at the apex and, coursing occlusally through the center of the tissue, give off many branches. Near the occlusal end of the pulp they further divide into capillaries and form a fine plexus around the peripheral portion of the pulp. The blood vessels are generously distributed through the tissue. The veins form a similar plexus and a central vein analogous to the artery receives the blood from these many venules and conducts it through the apical foramen.

Especial interest attaches to the thinness of the walls of the pulpal vessels. The arteries are almost entirely without the external fibrous coat and the muscular layer is represented by a single involuntary fiber, while the veins have only a single layer of endothelial cells to form their walls. For this reason the pulp is particularly unable to resist any tendency to hyperemia, and as the tissue in confined in a cavity with unyielding walls, the pulp-cavity, and as the apical exit from it is small and easily blocked, hyperemia of the pulp is attended with a greater amount of pain than in any part of the body, because the nerves are easily stimulated by the pressure of the blood in the pulp-cavity. When inflammation supervenes and inflammatory products are to be removed, the absence of lymphatics further adds to the difficulties of the situation. These facts explain the observed clinical experience associated with pathological conditons of the pulp.

The nerves of the pulp are transmitted through the apical foramina together with the blood vessels. Several bundles of a medullated nerve fibers enter the foramen and break up into a plexus of nerves which are widely distributed through the pulp tissue. Just below the layer of Weil, the fibers may be seen to lose their medullary sheath, when they penetrate this and are lost between the odontoblasts. None have been traced into the dentinal tubules. The sensory nerves of the pulp are only capable of transmitting sensations of pain, which may arise from mechanical, thermal, or chemical stimuli. It is not possible to localize these sensations to any particular tooth, so that one is not able to refer them to the tooth in which they arise. Pain originating in one tooth may be referred to any other in either the upper or lower series.

It has been said that the pulp had for its function the nutrition and

innervation of the dentin. While dentin is of course a non-vascular tissue, the physical differences in new dentin and that which is found in an old tooth are often so great as to warrant the belief that in some way it may be changed after it has formed. This of course can only be through the medium of the protoplasmic contents of the tubuli, but how this occurs if at all is still only a matter of conjecture.

This is also true of the sensory innervation of the dentin. The dentin is sensitive to stimuli of a chemical, mechanical or electrical nature, and the dentinal fibrils are instrumental in delivering these. No nerve fibers have been traced into the tubules, but nerve endings are closely associated with the odontoblasts. It is believed that the dentinal processes of these cells in some way transmit the stimuli. Of course with the removal or death of the pulp, all sensitivity of the dentin ceases.

THE PERICEMENTUM

The fibrous membrane intervening between the root of the tooth and the alveolus is known as the *pericementum* or *peridental membrane.* While not a tissue of the tooth proper, it serves to connect it with the osseous skeleton and performs so many functions associated with the tooth that it deserves especial attention.

It is composed chiefly of white fibrous connective tissue, and besides containing the blood vessels and nerves necessary for its proper functioning, contains a variety of other cellular elements, the functions of which will be discussed later. The chief office performed by the pericementum is the retention and support of the tooth in its socket, in addition to which it has a developmental and nutritive relation to the cementum and the alveolus, and serves as the touch-organ of the tooth. Inasmuch as the fibrous elements of the membrane are in predominance and as they are related to its chief function, they will be described first.

The fibrous tissue of the pericementum is of two kinds—first, the principal fibers, so called by Black because they were greatest in number and most important in function, which extend from the cementum to the alveolar wall or into the gum tissue and are attached to each; and second, the interfibrous tissue, which is the fibrous tissue composed of spindle-shaped and stellate cells which intervenes between the principal fibers themselves and between these and the other pericemental elements. These fibers pass from the tooth to the alveolar wall in all portions of the socket, their ends are firmly built into the cementum at one end, in which they are spoken of as Sharpey's fibers, and into the bone of the alveolar process at the other, and they mechanically support the tooth in its socket. Their arrangement is somewhat different in different parts of the mem-

brane and so it will be necessary to give their direction in its various portions. In the gingival portion of the membrane, where they are thickest, they extend from the cementum in three directions. (Fig. 104.) One set passes occlusally into the gingivus to support this and make it hug the neck of the tooth, and another passes over the alveolar border to blend with the fibres of the muco-periosteum of the alveolar process. These two sets of fibers are in greatest abundance on the lingual side of the

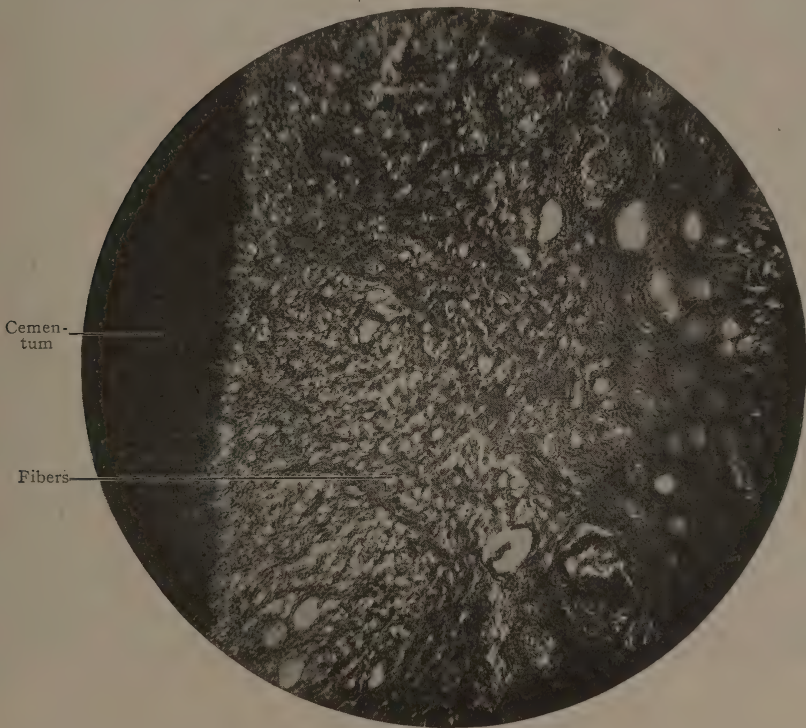


FIG. 104.—Section showing pericemental fibers attached to the cementum. (Broomell.)

teeth, serving to protect this against violence from food in mastication. The third set of fibers passes almost horizontally outward and they are either attached to the alveolus, or on the proximal sides in young subjects they pass over to the adjoining tooth and become continuous with its pericemental fibers. Of this third set of fibers, some pass radially directly to the alveolar bone, and on the lingual side these are most numerous, while others after leaving the cemental surface pass tangentially in bundles, and are attached to the process at points mesial or distal to where a radial direction would have taken them. These fibers serve to prevent the rotation of the tooth about its long axis, while the radial fibers resist force tending to move it laterally.

In the membrane intervening between the gingivus and the apex of the root, the principal fibers pursue either a straight horizontal course from cementum to bone or they are directed occlusally. The effect of this arrangement is to swing the tooth in its socket, as it were, and it enables the tooth to resist the force of mastication or any other which tends to depress it in its socket. (Fig. 105.)

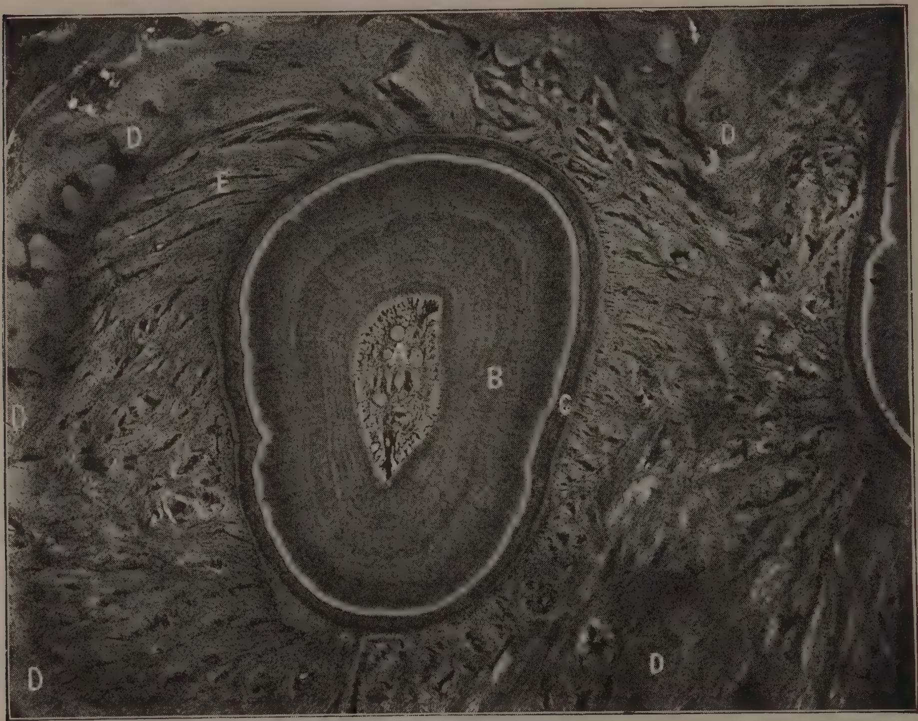


Fig. 105.—Section through alveolus and root of lateral incisor near the gingivus showing direction of fibers of pericementum. A. Pulp with blood vessels and nerves. B. Dentin. C. Cementum. D. Alveolar process. E. Interfibrous portion of pericementum. (Noyes. *Angle's Orthodontia.*)

In the apical region the principal fibers extend radially from the root, spreading out from it in all directions to the alveolar socket.

The interfibrous tissue fills in the spaces between the principal fibers which is not occupied by the blood vessels and nerves and the special cellular elements presently to be described.

This arrangement of the fibers of the pericementum is remarkably adapted to hold the tooth in its socket, to enable it to resist stress placed upon it, and yet to yield slightly to the stress and thus to break the force of the latter. While the fibrous tissue is of the inelastic variety, the fibers are not on tension all the time, and thus permit a certain elasticity to the tooth. This elasticity is contributed to in the young membrane by the blood vessels, which are very numerous, a condition which has a

cushioning effect upon the tooth. This elasticity permits the slight movement of teeth when separating them for operative procedures and in the beginning of their orthodontic treatment.

The cellular elements are fibroblasts, cementoblasts, osteoblasts, osteoclasts, and certain epithelial structures.

The *fibroblasts* are long, spindle-shaped cells found in greater numbers in the young membrane and almost absent in that of old age, and are for the repair of the fibrous tissue. They may be observed in the bundles of principal fibers.

The *cementoblasts* which are concerned with the formation of the cementum, are flat, scale-like cells found on the surface of the cementum occupying spaces between the principal fibers. They are irregular in outline and the bay-like depressions in their periphery are occupied by fibers. They have oval nuclei and are difficult to find in longitudinal sections.

The *osteoblasts* are situated upon the alveolar wall which they assist in forming. They are spherical cells with round nuclei like osteoblasts elsewhere found in periosteum. They build the bone around the fibers of the pericementum, thus strongly attaching it to the bone, and the calcified fibers are here also known as Sharpey's fibers.

The *osteoclasts* are not constantly present in the pericementum, but are found when absorption of the calcified tissues is in progress. They are often spoken of as "giant cells" because of their size and the great number of their nuclei of which as many as twenty-five are sometimes found. They are capable of acting upon bone, cementum or dentin. Although the exact manner in which they remove the calcified tissue is not known, it is necessary for them to be in contact with it and they are found in the bay-like excavations which they have produced. These excavations are known as "Howship's lacunæ."

The *epithelial structures* of the pericementum were first described by Black, who referred to them as the glands of this tissue. While their glandular character has not been demonstrated, they resemble the glandular tissue in that they are chains of cells epithelial in all their characteristics which are distributed throughout the membrane. Occasionally they appear arranged as a tubule having an imperceptible lumen, but no connection with the oral epithelium has been traced.

They are doubtless remains of epithelial tissue carried down from the oral epithelial at the time of the formation of the enamel organ. They are fairly uniformly distributed through the membrane according to a diagrammatic plan by Dr. Black.

The *blood vessels* of the pericementum are numerous and are derived from three sources. Two or three branches are given off by the artery of the pulp before it enters the apical foramen. These anas-

tomose with branches of arteries from the alveolar process and with others from the mucous membrane at the gingival margin, forming a plexus of arteries which bountifully supplies the membrane. These are more numerous in the young specimen and occupy approximately the center of the tissue, but decrease in number and size as life advances and in old age are found in channels upon the alveolar wall.

The *nerves* are derived in a similar manner from those entering the pulp, from the bone itself and from the mucous membrane at the gingivus. They unite and give the tissue an abundant nerve supply. The medullated fibers terminate without special nerve endings. They transmit sensations of pain and ordinary sensation and thus the pericementum is the touch-organ of the tooth.

CHAPTER III

HYGIENE AND ARRANGEMENT OF LIGHT IN THE OPERATING ROOM

BY C. N. JOHNSON, M. A., L. D. S., D. D. S., M. D. S., F. A. C. D.

The hygiene and control of light in an operating room is a very important matter, affecting as it does the health and comfort of the practitioner. In an office where the dentist is confined chiefly to operating, as is the case in so many today, it is essential that some attention be given to the room where the working hours are mainly spent. It is undoubtedly true that many dentists have seriously impaired their health and shortened their years of usefulness by confining themselves in an abnormal environment, and the subject is worthy the careful study of every operator.

The first essential in an operating room is good ventilation and sunlight. The operator should not stand in a draft but he should have plenty of fresh air and not breathe the vitiated atmosphere so frequently found in dental offices. The admission of sunlight is very important if it can be arranged without taxing the operator's eyes, though this is not always possible with the location of many of our offices. Sunshine is a greater purifier and is worthy of more consideration in this respect than it usually receives.

There is a difference of opinion among practitioners as to which is the preferable light for operating, very many urging the advantage of a north light, but this has the limitation of not admitting the sun. It would seem that the best arrangement was to have a corner room for operating with two windows in it, one for the operating chair and the other to admit sunlight. A north-west room lets in the sun only in the afternoon and in the summer is very hot, and the same may be said of a south-west exposure. A north-east room is better, having the chair face the north window with the east window at the operator's back. But this room admits very little sunshine in the winter months when it is most needed. What is probably the best arrangement is to have a south-east exposure with the chair facing the east. The sun is usually so high by the time operating begins that it does not interfere with the work, and in summer it is so far north that it does not shine

in the south window sufficiently to cause undue heat. During the winter months it pours into this window, flooding the operating room, coming in at the operator's back, and therefore not injuring his eyes by causing too bright a light to shine in front of him.

This is a very important consideration which many practitioners overlook—the avoidance of too much light for the operator to face. There is a constant tension on the eyes when the individual is looking toward a light, and this is equally true of a reflected light which enters from the rear and is thrown back in the face by a bright wall in front. This makes it very essential that the color of the walls in an operating room should be such as to absorb light and not reflect it. Bright colors are to be avoided in decorating, and this one room of all others should be given over to service rather than to attempt to make it attractive by the use of light shades. Fortunately it may be made comfortable to the eyes without sacrificing artistic beauty if the proper colors are selected. Where paper is used on the walls it should be a solid color without pattern. Green is a suitable shade as also is the deep brown known as chocolate. The latter produces a soft, restful effect in a room, unobtrusive in any way, and unobjectionable from an artistic sense.

The size and location of the window in front of the operating chair are important factors in securing effective light without eye strain. The window should be sufficiently high to carry the light directly down from the sky into the patient's mouth when the head is tipped slightly back, and there should be nothing to interfere with the direct passage of the rays such as trees in front of the window or tall buildings standing too near. A very common error made by practitioners is the admission of too much light in the operating room. The idea seems to prevail that the more light the better, but this is a serious mistake. It is true that a very excellent quality of light is required, and in the immediate vicinity of the patient's mouth the light cannot be too strong short of sunshine. But this is the only vicinity where it is needed, and the diffusion of light over a wide area by having a very large window in front of the chair is a severe tax on the eyes which few operators realize. If a window is too large some of the light should be shut off with a shade, and this is particularly true where the window runs down so near the floor as to flood the lower part of the room with light. The operator is looking downward much of the time and this flood of light is reflected in his eyes. In any arrangement of an office whereby an operator must use one window for operating and face another as he stands at his chair he should cut off every ray of light from the window he faces by a dark shade, and in the same connection he should avoid anything on the wall in front of him which will reflect the light in his face. A bay window while

very alluring to some practitioners is extremely bad unless the window looking toward the operator's face is heavily shaded. The only direction from which it is permissible to admit light to the room except that which comes straight to the patient's face is at the operator's back, and as has just been intimated there should be nothing in front of him which would reflect this light back in his eyes.

Many operators go on year after year suffering eye strain and unconscious of the cause of their discomfort through ignorance of the essentials necessary in the arrangement and control of light in the operating room, or through carelessness in carrying them out. When it is considered how important the eyesight of the dentist is it would seem only a reasonable supposition that every operator should give some attention to a matter so vital to his future comfort and usefulness. The essentials are simple and are capable of being carried out in a reasonable degree at least by every practitioner.

CHAPTER IV

ASEPSIS IN THE OPERATING ROOM

BY A. E. WEBSTER, M. D., M. D. S., D. D. S., F. A. C. D.

Under this heading must be considered the possibilities of patients carrying contagious diseases to the dental office, and other patients becoming infected from the germs of disease left in the plush dental chair, the carpets, curtains, and hangings about an operating room. There is also the more frequent and possible means of transmitting disease to be considered, the actual contact from instrumentation.

It may not often occur in an ordinary practice that patients suffering from a contagious disease apply for dental treatment, but it does often happen that patients apply while members of their family are suffering from a contagious disease. Such diseases as measles, diphtheria, whooping cough, scarlet fever, chicken pox and small pox are said to be capable of transmission by clothing. Then there are such diseases as tuberculosis, pneumonia, influenza and some pus infections which may be transmitted by an unkept office equipment. Disease may be transmitted through the water supply, the air supply or noxious gases. Even darkness is conductive to the growth of micro-organisms.

To minimize as far as possible the transmission of contagious diseases in a dental office the operating room should have an abundance of direct sunlight, there should be no draperies or hangings about the room. The walls should be of hard finish and capable of being easily cleaned. The wood work should be of plain finish, no crevices for the collection of dust. Cabinets, brackets and shelves should be plain and of hard finish. Drawers should not be lined with baize or fabric of any kind. The chair, and especially the head rest, should be covered with some material which is capable of being cleaned without destruction. Plush is decidedly objectionable. Paper or clean linen covers should be provided for each patient. The floors should be capable of being cleaned, as is the case with hard wood finish or linoleum put down in a whole piece and cemented at the edges so that water may not get under it. If a rug or cork is used to stand upon at the chair, it can be cleaned frequently. Carpet in an operating room is the most unhygienic of all floor dressings.

Typhoid fever and other intestinal infections are most frequently

transmitted by the water supply. In some cities and towns the water is never fit to drink, while in others it may be drunk if boiled and in others the water may be unfit for use only at certain periods. Water which is unfit to drink is unfit to wash a drinking glass or to rinse the mouth.

The air supplied to an operating room is of importance, especially to the operator, because he so constantly breathes it. Hot air heating often supplies air which is obtained from a dirty, damp basement or from nearby sewer ventilators. Sewer gas often enters an operating room from poorly trapped or ventilated plumbing. The fountain cuspidor is rarely trapped and is often the source of sewer gas. Coal gas leaking from defective pipes is an insidious kind of poisoning that an operator may not notice for months. The proper ventilation of an operating room deserves some consideration.

The keeping of an operating room aseptic is no small undertaking. In fact it is well nigh impossible and yet it may be kept clean enough so as not to be the means of spreading contagious diseases. Dust is the enemy of cleanliness and health. Every crevice, every crack, every shelf and every loose fabric is an element of danger. The walls, shelves, brackets, cabinet, chair, woodwork, light fixtures, windows, in fact everything should be thoroughly cleaned once a week, with brush, soap and water. After this the room may be closed up and formalin gas set free in sufficient quantity to fill it and allowed to remain for some hours. Formaldehyde tablets may be evaporated by heat over a Bunsen burner. Three or four tablets may be placed on a piece of flat metal over a gas flame. The heat necessary to evaporate the tablets is not very great. An equally efficient method is to place a couple of ounces of formaldehyde in a dish over the Bunsen flame which will quickly drive off the formalin gas. Once the gas begins to come off, no one should remain in the room because the gas is very irritating to the air passages. The small appliance used by public health departments is very satisfactory for fumigating a dental office. (Fig. 106.)

FIG. 106.

The floors, chair, cabinet, bracket and all handles should be carefully cleaned and dusted every day or as often as necessary with a damp cloth wrung out of a five per cent phenol solution, and, if there is any reason for suspecting that a patient has been in the office who was suffering from a contagious disease, there should be a general disinfection, fumigation and ventilation.

Such parts of the furniture and equipment as the operator is likely to handle in his ordinary duties should be wiped off with a cloth made damp by a five per cent solution of phenol or bichlorid of mercury one to the thousand. There should be no waste cotton or dressings permitted to fall upon the floor. There should be a convenient receptacle for such things that can be emptied frequently and sterilized. There is nothing more unclean than the ordinary cotton holder where the plier points are drawn over the edges to remove the cotton, unless the holder is sterilized after each operation. Soiled towels, wipes, napkins, and rubber dam should be immediately removed from the operating room. Small paper boxes are satisfactory for ordinary cases, but sterile wipes should be used during root canal work.

The dental cabinet should be thoroughly cleaned and wiped out with a cloth made damp with a five per cent solution of phenol once a week, and disinfected by the evaporation in it of formalin gas. Each tray and shelf containing operating instruments should be cleaned daily. Besides this the tray containing operating instruments should be covered with some material which can be easily removed and sterilized or destroyed. No instruments should be permitted in the cabinet until they are first sterilized. A fairly thick paper is quite suitable to cover the operating tray and may be removed after each patient and a new one placed in position. What are known as hygienic trays which are made of glass or granite are suitable and readily cleaned.

The table on the bracket arm is often made of such materials and of such a form that it cannot be kept clean. A simple plain table of glass without any elaborate frame to hold it is all that is necessary. Once any decoration is attempted there are crevices for dust. With the swinging trays from the cabinet it is not necessary that the table should contain places for the operating instruments, medicine bottles, gold, amalgam and cement. The fact is the aseptic cabinet and bracket table and chair covering are not yet manufactured. They have not been demanded. The bracket table may be covered with a thick paper which can be removed after each operation and destroyed.

The operator should be suitably dressed for the work he has to perform. His coat should be of washable material, close fitting around the neck and sleeves, no buttons or flaps to catch in his patient's hair or clothing. Many operators prefer the arms bared of shirt and underwear to the elbows and a loose sleeved coat or gown reaching midway between the wrists and elbows. Clean white suits and gowns are preferable to coats or gowns alone.

Long hair and whiskers are not conducive to aseptic operating. The operator should aim to prevent his expired air from entering the patient's

mouth or nostrils, and he should also avoid as much as possible taking in the expired air of the patient.

An operator's hands are almost impossible of disinfection; because though the surface may be sterile for a while it soon becomes infected from the natural exudations from the deeper parts of the skin. These exudations may be hindered for a time from pouring out their secretions by applying astringents but the more the hands are used the more active the glands become. Hands which are covered with a smooth unabraded skin and have regular well kept finger nails can be made more aseptic than the dry, scaly hands with rough, irregular nails. Rough and violent scraping of the hands is likely to put them in such a condition that even

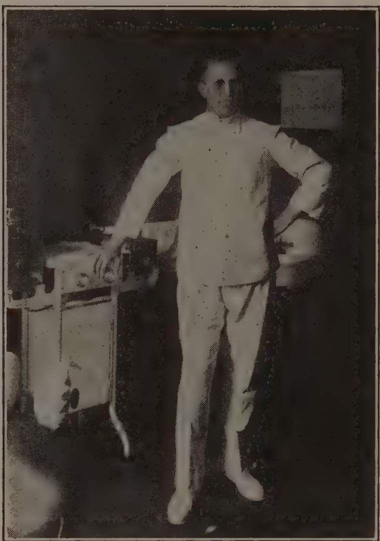


Fig. 107.

Fig. 108.

this will not clean them. Nails are difficult to keep in condition unless kept short and smooth by files and brushes. Sharp instruments should not be passed under the nails to clean them because they scratch the tissue, leaving opportunity for lodgment of infections. Orangewood properly trimmed will serve to clean under the nails without wounding. The dentist should look upon his hands as one of his assets and should avoid everything that might in any way disfigure them or roughen the skin. A complete manicure set might well be part of the equipment in every dental office. The hands should be carefully washed in warm water and soap for five minutes, the nails scrubbed thoroughly and cleaned beneath and again washed in running boiled water. This will suffice for ordinary cases, but if the hands have been exposed to pus infections or the saliva of the patient, or an operation is to be performed which demands the

breaking of the mucous membrane or entering the circulation of the patient greater care must be exercised in cleaning them. They should be washed as above and then immersed in a one in forty phenol solution from three to five minutes or a two per cent solution of permanganate of potash, or one in a thousand bichlorid of mercury. Following this, alcohol may be poured over them. But if absolute certain asepsis is demanded rubber gloves should be worn. The general surgeon of today will not depend upon the disinfection of his hands, but wears gloves. There is no doubt that the dentist's great precaution should be to prevent the transmission of infection from one to another. While the patient may become infected from his own saliva the dangers are not so great as from infection from without. As the dentist operates for a patient his hands are certain to become infected from contact with the patient's lips, face, mouth or clothing, and should be again cleaned and disinfected as parts of the operation are reached which demand aseptic conditions. The operator should avoid touching his clothing, his face, hair, or the furniture while treating roots of teeth or doing operations which may bring his instruments in contact with abraded surfaces.

The field of operation should be as carefully prepared as the hands or instruments. Patients often visit the dentist whose mouths are not even freed from particles of food from the last meal or two. It is well to have such patients rinse their mouths as thoroughly as they can with a two per cent solution of permanganate of potash before even a thorough examination is undertaken. A blast of air from a compressed air tank or a spray containing one of the essential oils in water will clear an area for inspection. Not having these appliances a stream of tepid water forced between the teeth will clear out an interproximal space. Large cavities containing decomposed food and decalcified dentin should be opened and washed out with an abundance of water. If the cavity is to be filled at once or the pulp involved the teeth in its vicinity should be dried and wiped with alcohol, and, if the rubber be in position all of the exposed teeth should be thoroughly sopped with a strong disinfectant. Root canals should never be opened without thoroughly cleansing the cavity itself and the teeth about.

Pulp and root canal treatments must be looked upon as surgery, having all the possibilities of infection as opening into the general circulation in any other part of the body. It is really bone surgery and is fraught with all the possibilities of infection as such operations are on other hard parts. The war has proven that where bones have been invaded special care must be taken against infection else there will always be a focus of reduced resistance if not a positive center of infection. Bone repair is slow and never is as resistant to irritants as it was originally.

With this knowledge comes the imperative demand that such operations must have as great care in matters of asepsis as bone surgery itself.

The sterilization of instruments is perhaps more important than the sterilization of hands or the field of operation because they more frequently come in contact with the secretions of the body. This is especially true of extracting forceps, lancets, clamps, separators, matrices, files, trimmers, scalers, broaches, explorers, and hypodermic needles. Instruments should be selected with a view to their easy sterilization. Cone socket instruments and deeply knurled or wooden handles are not so easily sterilized as all steel and fairly smooth instruments. The dental handpiece is one of the most difficult of all instruments to sterilize. Boiling or heating to sufficient temperature to sterilize removes or destroys

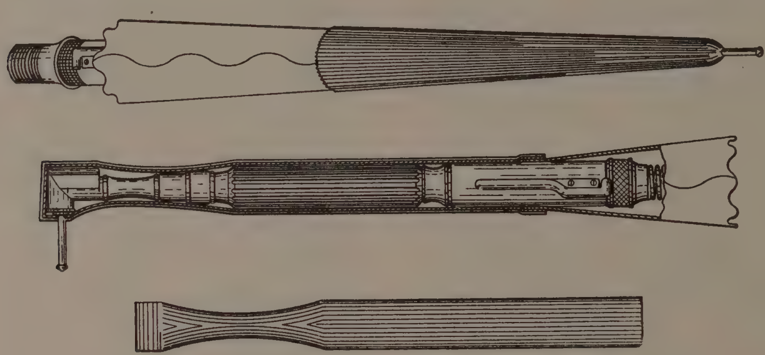


FIG. 109.

the oil in the moving parts. The surface is often rough and hard to clean and sometimes made of vulcanite with many crevices. The right angle and the contra angle are even more difficult to clean than the straight handpiece and are more likely to come in contact with the secretions of the mouth. It is remarkable how dentists will sterilize all other instruments very carefully, and leave the handpieces to take care of themselves. Some dentists have given it up as hopeless. A thorough scrubbing on the brush wheel with soapy water which is not allowed to enter the mechanism and drying with seventy per cent alcohol is fairly satisfactory. Many dentists have the handpiece covered with a small towel or napkin for special cases. This can be readily done by beginning the wrapping at the point and allowing towel to be held in place by elastic bands.

More and more paper is being used for aseptic purposes because laundry is expensive and uncertain. The paper cup, the paper covering for tables, the paper towel, the paper wipe or napkin, paper absorbents, and paper root canal points have largely taken the place of glass, metal, and cotton for these things. So it is with the handpiece cover. There is

a paper handpiece cover which can be made so cheaply and so readily sterilized that no one would take the trouble to sterilize a handpiece after each operation as should be done. As well as being a covering for the handpiece, it prevents oral secretions from entering at the point of insertion of the bur. (Fig. 109.)

There are two general methods of sterilization in common use (1) thermal (2) chemical.

1. Thermal—
    (a) Boiling in water.
    (b) Passing an instrument through a flame.
    (c) Moist heat in closed or open chamber.
    (d) Dry heat in closed chamber.
2. Chemical—
    (a) Phenol followed by alcohol.
    (b) Other coal tar products followed by alcohol.
    (c) Formaldehyde gas in an air tight chamber.
    (d) Other chemicals, *e.g.* bichlorid of mercury solution Tc. Iodin, etc.

As a rule heat is more certain, but even boiling for ten or fifteen minutes will not destroy the spores of some organisms. Sterilizers are

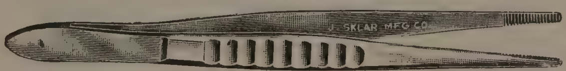


FIG. 110.

most satisfactory which will permit of the instruments being lifted in a tray and allowing them to dry from their own heat. Sterile instruments should be handled with heavy pliers about nine inches long made for the purpose. (Fig. 110.)

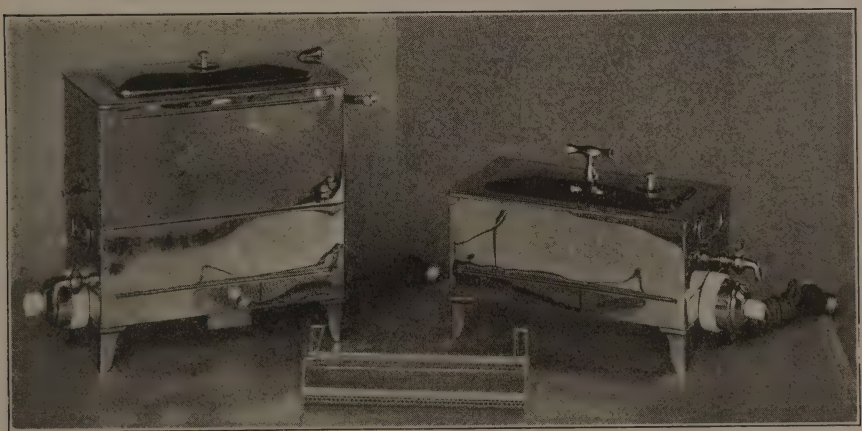


FIG. 110*a*.

Boil ordinary instruments in a two per cent solution of washing soda in water for twenty minutes. Boil fine cutting instruments and broaches

twenty minutes and store in two per cent solution of formaldehyde. Use boracic acid to prevent rust. Renew this solution every half day.

All instruments must be washed, dried, sharpened, polished and sterilized after each operation. If not immediately needed, they should be put in the proper places in the cabinet. If needed at once, placed in a sterile towel and arranged for use on the bracket table.

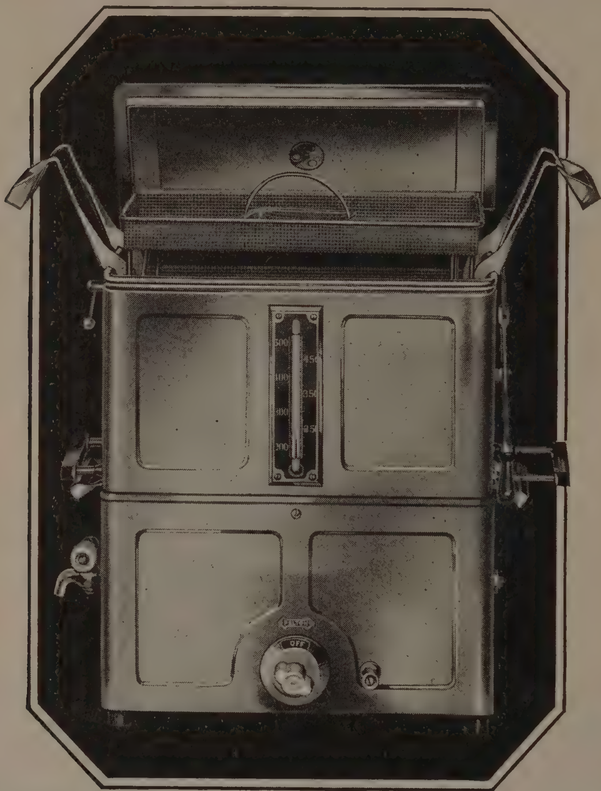


FIG. 111.—"PELTON" Steam Sterilizer. For the sterilization, by live steam, of cotton rolls, pellets, gauze, paper points, etc.

Before an operation which involves the soft tissues is begun, the instruments in the cabinet must again be sterilized and placed on the bracket table, which has upon it a clean cover.

There is little purpose served in sterilizing steel instruments and equipment, hands, and furniture unless equal care is taken with all the dry equipment such as gowns, coats, towels, wipes, rolls, cotton wool, paper and cotton points for root canals. Included among these may well be mentioned table covers, instrument covers, head rest covers, and patients' hand towels.

There are many styles of sterilizers on the market for general sterilization in connection with hospital work but it is only within the last few years that any attempt has been made to supply the dentist or surgeon with a sterilizer of convenient size for a private office. Most such instruments are made for boiling water only and are not large enough to sterilize coats, gowns, or towels. A sterilizer with a double chamber, one for water and one for dry materials, heated with electricity and with an automatic shut off for the current is quite satisfactory. (Fig. 112.) Some of these instruments are so made that gas or gasoline may be used for heating.

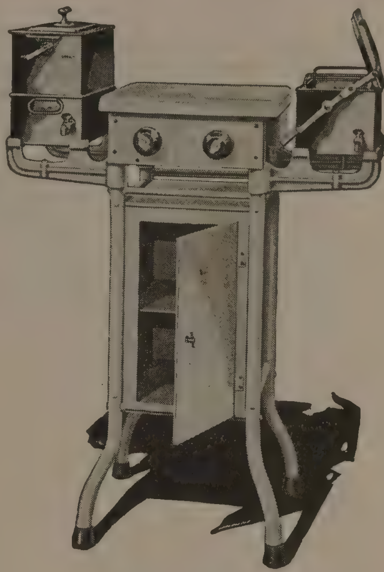


FIG. 112.

For instruments and small dressings only, a single chamber device will do. (Fig. 113.)

No sterilizer serves its purpose in a modern dental office which is not large enough to hold dry equipment for a day's work.

While it is important to be able to sterilize both instruments and dry equipment, it is equally important that such equipment be kept sterile until it is required. Instruments cannot be kept sterile in an open cabinet for any length of time. They should be sterilized immediately before using and while waiting kept under a clean dry cover. Dry equipment can be kept sterile for quite long periods as is exemplified in media kept in test tubes by loose cotton plugs. Gowns, coats, towels, wipes, cotton pellets, rolls, and paper canal cones should be folded and fastened in covers in such a way that by grasping a corner with the pliers the contents will be exposed ready for use without any handling of either cover or contents. (Fig. 114.) Only enough dry equipment should be in each package as is required to supply the

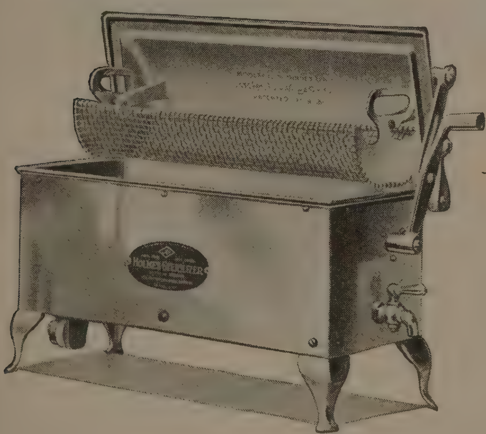


FIG. 113.

needs of one patient. If any should remain unused, it may be put into new packages and again sterilized. The following is a fairly complete list of what should be ready for use at all times.

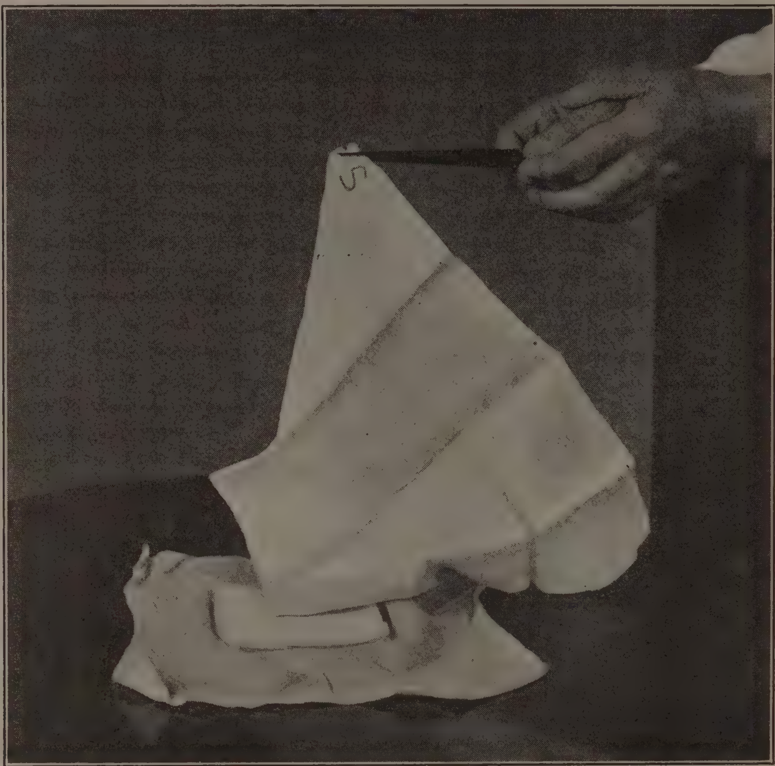


FIG. 114.

Sterile Equipment Ready at all Times

2 Gowns
3 Towels
10 Packages of wipes
10 Packages of small cotton pellets
10 Packages of larger pellets
5 Packages of rolls
5 Packages of loose cotton
2 Packages of cotton throat packs.
12 Cotton rolled orangewood sticks.
5 Packages of paper root canal points
25 Assorted gutta percha cones
Rubber dam
Rubber gloves and glove case
Silk ligature (flat)
Cold water.

Sterilization by drugs is not always satisfactory because efficient drugs have to be used in such strength that unless the instruments are wiped dry before using there is a possibility of injuring the patient's mucous membranes. The odor and the time required for some drugs to act are

serious objections. A three to five per cent solution of formaldehyde will sterilize instruments in a shorter time than any other drug or combination of drugs which are at all suitable for the purpose. Formaldehyde solutions will rust instruments rapidly but if borax be added rust does not occur. No dependence should be put in proprietary disinfectants for either the mouth or instruments. Sufficient tests of the efficiency of these nostrums have been made to prove their uselessness.

Such instruments as burs and those having serrated surfaces should be cleaned with a brush before being sterilized. The revolving brush wheel on the engine for cleaning burs is objectionable and should go

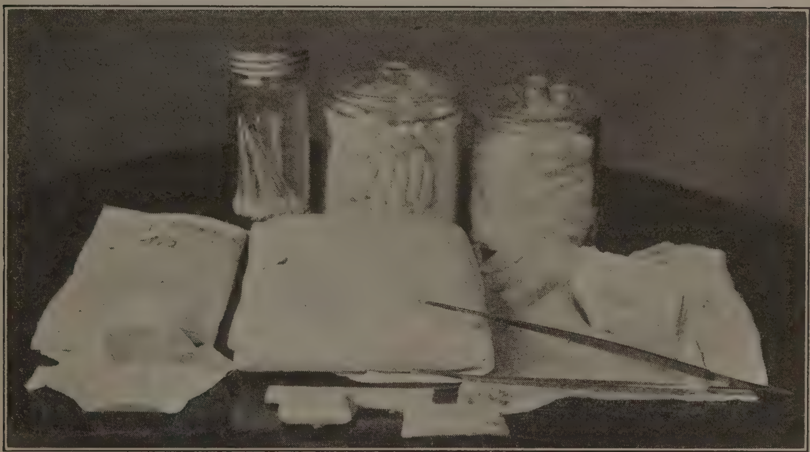


FIG. 115.

with the cotton holder unless cleaned after each time it is used. After broaches are sterilized they should be kept in a shallow receptacle containing a solution of an antiseptic which is odorless and will not rust instruments.

The hypodermic needle may be pressed into a cork which tightly fits the bottom of a glass barrel about an inch in diameter and three or four inches in depth. The cork may be saturated with any sterilizing fluid which will not rust the needle. Such a needle is always ready for use. If the barrel be deep enough the whole syringe may be kept within it and covered with another cork. The nozzle of the water syringe should be kept in the formaldehyde solution when not in use. The nozzles of the spray bottles should be similarly sterilized.

The sterilization of materials used by the dentist deserves some attention. Gold, amalgam, cement, and gutta-percha for fillings need little attention except where they are brought into contact with vital tissues. Gutta-percha is frequently brought into such contact but it is sterilized

by heating before being used. The phosphoric acid and chlorid of zinc prevent the carrying of infection by the ordinary cements. Gutta-percha points used to fill root canals are often inserted directly from an unclean drawer or box. They should be kept in seventy per cent alcohol in a wide mouth bottle well stopped.

There are many minor operations performed by the dentist which are cared for in rather a slipshod method. Roots of teeth are extracted about which purulent infections existed and no attempt made to wash out the cavity with any regard for asepsis. The water used and its containing vessel should be boiled, the syringe and the packing should be sterile. Every office should be equipped with sealed glass jars containing strips of boracic and plain gauze of different widths wound on spools. Cotton wipes may be kept in a similar jar. The jar and its contents may be sterilized in an oven or boiling water. The ordinary fruit sealer is an excellent jar for this purpose. (Fig. 115.) With such an equipment the dental surgeon is always prepared for the management of the many emergency surgical operations he is called upon to perform.

CHAPTER V

HYGIENE OF THE MOUTH

BY GEORGE H. WRIGHT, D. M. D.

ORAL HYGIENE OF THE INFANT

The highest physical development of the child is largely dependent upon its environment and its food. These two factors may be influenced by the parent and oral hygienist.

We have purposely placed a certain responsibility upon the Oral Hygienist instead of the general practitioner of dentistry, because the former is becoming a necessary adjunct in the care of children's teeth, as also an important factor in their education in matters of general hygiene. The Oral Hygienist's contact with the mothers of children under her care affords a splendid opportunity for an exchange of ideas as to the status of the child in growth; *i.e.*, its relation of age to height and weight and the various manifestations which are frequently recorded within the oral cavity, which may become an important index of the child's physical standing.

The dental hygienist has become an invaluable aid in the office of the practicing Dentist. Her work is doing more to prevent the destructive processes, that ensued under the old regime of general repair of the teeth, than any other factor in our modern practice of dentistry.

The value of her services is appreciated by leaders in industry who have established clinics for the cleansing of teeth in their departments throughout the United States. The demand for Hygienists increases each year for public health work and they are immediately employed on graduation.* In the Forsyth Dental Hygienist Clinic, Boston, last year over 25,000 children had their teeth cleansed and were given instruction in Oral Hygiene. The percentage of teeth defects in the fifth and sixth school grades has been reduced in five years from 50 per cent to 38 per cent.

It has been found by the School Departments, Child Hygiene Division, that the early ages in school life of the child are best for the beginning of the care of the teeth. "To accomplish the greatest good, we must aim

* Reports 1921–1922, Forsyth Infirmary, Dr. Harold DeWitt Cross, Director.

at something higher than the mere repair and extraction of carious teeth, the correction of oral deformities and the treatment of adenoids and tonsils. The prevention of disease is equally if not more important than its treatment. To be of inestimable hygienic value to the rising generation of children in our vicinity, we must instruct them not only in oral hygiene but in general hygiene as well; it would improve their nutrition and consequently their physical and mental growth; it would lessen their liability to contract contagious and other diseases, and would place them in a better position to resist the same if contracted."

Therefore, any consideration of oral hygiene today must include a provision for a study of the factors which lead to unclean mouths and teeth, and also provide a means of correcting them through the employment of all the agencies at our command. This includes a recognition of the value of the services of the modern well trained Oral Hygienist who should coöperate in the care and protection of our young patients; giving them the timely instruction which means so much for their future welfare. And where the hygienist is working in coöperation with the progressive dentist, he will be able to give her such information considered valuable from the various departments of research in dentistry when the truth is established as to the influence of a balanced dietary in the preservation of the teeth.

In order to have a clear understanding of the conditions necessary for a sound oral hygiene we must recognize what physiological processes are concerned in the development of the oral cavity, the eruption of the teeth, and the possible changes which may follow any interference with its normal process and which may result in a distinct pathological manifestation. Heretofore, in dealing with the problem of oral hygiene, we have considered simply the adult, now we propose to take a view of the child at the beginning.

The erupting tooth of a child slowly develops to the surface after absorption of the alveolar periosteal crypt, immediately above, and ultimately cuts its way through a fibrous mass of gum tissue. It is hastily assumed that all possible disturbance with that particular tooth has ended, but a few hours later, or the next day, the tooth may disappear below the gum into its crypt, leaving a small orifice capable of lodging decomposing food and myriads of bacteria.

The fluctuating of the teeth in their coming and going shortly after their first appearance, is undoubtedly due to the change in arterial tension which is manifested through the large vascular pulp of each tooth. It is possible to record the pulsations of the heart, and count its beat through the freshly erupted tooth. The writer has made observations during the past few years and watched this phenomenon.

Under normal conditions, the process of eruption is a natural and orderly physiological procedure on the part of nature. It is not our intention, nor within our province at this time, to go into details concerning the periods at which the groups of teeth erupt; that has been dealt with in another chapter. We shall consider, however, those aspects which either directly or indirectly induce disturbances within the oral cavity, and which we are called upon to treat in order to establish a sound hygiene in the mouth.

Coincident with teething there may be a feverish restlessness, periods of excessive salivation, desire of the child to bite its fingers, and rub its eyes and nose. There may be bright red areas in the region of the parotid and sublingual glands externally; possible rise in temperature with fretfulness and nervous irritability, and reflex disturbances of digestion with frequent ejections of its food. The mucous membrane of the mouth, under these circumstances, may exhibit a hot and dry surface that lasts for a few hours to be followed by salivation.

The etiology of these disturbances in the majority of cases may be referred to improper feeding, as indifferent formula for artificial foods, too much food, uncleanliness, or indiscriminate feeding.

It is not inconceivable that some of the convulsive disorders of early childhood may be a reflex due to disturbances of the gastro-intestinal tract coincident with a localized high blood pressure within and surrounding erupting teeth. Under these circumstances a judicious lancing with a crucial incision over the site of the erupting teeth and a reduction in the diet will afford immediate benefit. Furthermore a faulty dietary accompanied by an unclean mouth and unclean naso-respiratory tract will soon be productive of an engorged mucosa resulting in enlarged lymphoid tissue as seen in overproduction of pharyngeal adenoids. A continuation of enlarged adenoids and lessened drainage and ventilation of the naso-respiratory tract will soon lead to an encroachment on the normal drainage of the eustachian canals giving rise to a suppurative otitis media and enlarged tonsils. This vicious circle continues until the child becomes an habitual mouth breather, thereby laying the foundation for future malformations within the mouth and a lack of harmonious facial development. We have frequently seen children with enlarged adenoids, victims of a haphazard dietary consisting largely of sugar and breads made from finely bolted flour, who have been operated on for the surgical removal of adenoids, returning again to the clinic for subsequent removal of adenoids, until intelligent coöperation with the parents was established in providing a diet that would finally relieve the child of all gastro-intestinal symptoms and ultimately show a reduction in the congestion of the oropharynx and nasopharynx.

The child taking its nourishment at the breast obeys a natural instinct, and the mother's milk during the first months of feeding increases in quantity with the larger demands of the child, and analysis shows a decline in the nutritive proteids toward the end of the period of lactation. The child thrives best at the breast when the conditions are normal. When otherwise, then artificial feeding by formula is resorted to, but instead of a decrease in the quantity and proteid constituents of the food as observed in nature's method, we find the exact reverse, and the child suffers in consequence of haphazard artificial feeding; where the food values are progressively increased, while the naturally fed child is getting but a simple diet and that sparingly. It is not a question as to how much food the child shall take, but how little it should take in order to preserve the balance of perfect assimilation and growth.

The salivary glands of the child are functionally active from four to six months and it is claimed that even in the youngest infant the chemical constituents of the saliva are capable of rendering soluble starchy foods; and some children have been known to digest and assimilate starch during the earliest months, yet upon general principles it is considered very unwise to introduce starchy food of any kind, because of the mechanical irritation and frequent inability to digest and assimilate them.

The one great remedy for reflex disturbances of digestion, as a result of undue tension within the highly vascular tooth pulp, will be found in reduced and careful feeding, and the establishment of normal hygienic conditions. It may be necessary to starve the child for twenty-four hours before beginning where nature serves at the breast, in order to build up again.

In describing the pathological aspect of the oral tissues in the child, the writer in the following has drawn largely from the admirable description found in Barrett's Pathology, Holt's Infancy and Childhood, and Forchheimer.

Stomatitis, in relation to disturbances or inflammation of the mucous membrane of the mouth and adjacent tissues, is in this sense restricted in its application; although the term is a broad one and could be applied to many diverse conditions. Stomatitis is common in infants, and is usually the handmaid of bad hygiene or unsanitary surroundings.

This inflammation of the mucous membrane is frequently found where the child is artificially fed, instead of nursing at the breast. Either the proportion or formula for food is wrong, or there is not sufficient cleanliness and care in scalding the bottles and nipples, which will inhibit the growth of fermentative bacteria. The quality of the rubber in the nipple undergoes change, and under the influence of light and heat decomposes and becomes an active source of irritation to the tissues, which

become poisoned. And even though these conditions do not exist as to improper feeding or unclean bottles, it is possible to develop a stomatitis on account of the accumulation of debris from remnants of food lodged within the orifices of erupting teeth, broken down epithelial cells, and combined products of inflammation, which should be daily removed irrespective of the age of the child. Sometimes the most careful and conscientious nurse or mother will neglect this duty.

A simple follicular stomatitis is an inflammation of the mouths of the mucous follicles. Small areas of the surface may be involved, and possibly induce degenerative changes as deep as the mucosa. The membrane will be flecked over with red points. As the inflammation spreads, more follicles become involved until the red points and patches merge, and the entire surface becomes turgid and tumid. As we look into the mouth, the tissues are hot, and dry, and red. There is considerable sensitiveness, and the child will shrink when examination is attempted. In the early stages, there will be excessive flowing of watery saliva due to the congestion of the blood vessels surrounding the glands, some febrile disturbance, bowels irregular, and either constipation or diarrhea predominating. Close examination reveals swelling of the muciparous follicles and possibly tiny cysts due to the accumulation of secretions within them. (Forchheimer.) The adjacent lymphatic glands become slightly enlarged and sensitive. Fortunately the constitutional symptoms with this form of stomatitis are not severe; there may be deranged digestion, vomiting, and a mild attack of diarrhea. The disease runs a brief course, and disturbances are usually easily corrected by care in feeding and cleanliness.

In later stages, the degeneration spreads, the mouth becomes dry and parched, the blood vessels are congested and active nutrition is interrupted; then comes stasis or stoppage of circulation, and sloughing of the tissue commences.

A child that is fed with a food that it cannot properly digest and assimilate will be poorly nourished, and as a result, almost any form of disturbance may ensue. The irritated condition of the digestive tract may produce diarrhea and gastric disturbances, and may result in ulcerative stomatitis. We have then an advanced stage of the first condition. The functions of the mucous follicles quite cease, and cracks and fissures open in the unlubricated tissue. All the preceding symptoms are aggravated. The child cannot take its food without difficulty, and what is ingested affords little nourishment because of the gastric disturbances that are always present.

Aphthous stomatitis, or herpetic stomatitis as Holt calls it, is a form that may attack people of almost any age, and is characterized by some special appearances. Small round or oval ulcers appear

upon the reddened mucous membrane of the lips, cheeks, tongue, or gums. They are from one to three lines in diameter, very little depressed, with a yellowish or white floor, and a red, narrow, perhaps slightly indurated, border. Sometimes two or more of them become confluent, thus forming an irregular, large ulcer. When these heal they leave no cicatrix. The aphthæ do not spread like the spots in ulcerative stomatitis, and they are distinctly painful, while the ulcers are not.

Usually there is an increased flow of saliva accompanying them, the mouth is hot and feverish and the tongue heavily coated. Sometimes the saliva excoriates the skin and the lips are thus kept constantly sore. The older ulcers may have the appearance of a diphtheritic membrane, being a dirty grayish color.

It is usually a self-limited disease and may cover a period from five days to two weeks. There is a considerable doubt as to its etiology, but Holt* and Forchheimer† agree that it is of nervous origin, and not proved to be contagious. It is frequently associated with disturbances of the stomach and an attack may be coincident with the eruption of the teeth.

Thrush is a form of stomatitis occurring in children and dependent upon the growth of a parasitic fungus. This consists of long, jointed threads, the saccharomyces albicans, which seem to belong to the family of the molds. Thrush is undoubtedly contagious. If a little of the exudate from the mouth is treated with a drop of liquor potassæ and examined with the low-power of the microscope, the structure will reveal the fine threads (the mycelium) and the small oval spores. Slight catarrhal stomatitis, inadequate salivary secretions and lack of cleanliness in the mouth will favor its development.

Wherever many young children are congregated, as in asylums, nurseries, and foundling homes, all are liable to contagion of the disease. It is most frequently developed in children suffering from malnutrition or other wasting diseases, or from any deformities within the oral cavity, as hare lip and cleft palate. On looking into the mouth of young infants a layer of thin white patches, almost a membrane, may be seen covering the palatal arch and appearing as white spots upon the tongue, while the mucous membrane about or at the borders of this coating seems to be in a healthy condition. The white flakes cannot be wiped or brushed off; any attempt to forcibly remove them will induce bleeding.

The preceding remarks are more especially applicable to infantile stomatitis. The same or analogous conditions may be induced in adults by like causes. Anemic and poorly nourished persons are especially

* Infancy and Childhood: Holt, 247.
† Archives of Pediatrics, ix, 330.

liable to inflammations of the oral tissues. The lips are dry and parched, and superficial fissures and cracks in the mucous membrane appear. In a less degree this will be observable upon the tongue, the buccal surfaces, and in the vault of the mouth. This may continue for some time, until finally, with the progression of a general febrile state, a more active stomatitis is developed that may result in a local breaking down or ulceration.

Neglect of the teeth and mouth tissues is a fruitful source of stomatitis in adults. Food is left to ferment and putrefy, and the products of this action will be exceedingly irritative to the soft tissues, as well as destructive to the hard. There will always be gingivitis present in the mouths of those who do not give proper attention to the removal of foreign substances from about the teeth, and this, by continuity of tissues, may spread all over the mouth. Usually the action of the saliva upon the portions freely washed by it is sufficient to keep them clean and normal. But between and about the teeth, where food remains for an indefinite time, in the absence of proper care the gums are always irritated and more or less congested, and this may spread to adjoining tissue, with the result of an acute stomatitis in atonic conditions.

In infantile affections the very first measures to be adopted necessarily imply an inquiry into the food and feeding. If the child is artificially fed, the nursing-bottle should be carefully inspected, and the food that is given must be scrutinized. If there is anything unsanitary about either, it must be at once corrected. The rubber nipple must be sterilized, or, what is better, *discarded* and substituted by a new one that has been made thoroughly aseptic. If the child is poorly nourished through improper or insufficient food, that must be remedied, and plenty of nutritious matter that can be readily digested and assimilated should be given. If there are diarrheas or other wasting disorders, which will too often be the case, they must at once be attended to; it will be impossible to build up a patient while any process of waste is going on. All unhygienic surroundings must be remedied, and the patient should be given plenty of light and air, and proper exercise. In short, beneficent Mother Nature, upon whom we must finally rely for a cure, must be afforded every opportunity. Functional activity must be promoted, and all obstacles removed.

After securing perfect sanitation the local treatment will be mainly depurative and stimulative. If a cathartic is indicated, two drams of castor oil may be administered. For the local irritation, a mouth wash consisting of a solution of five to ten grains of chlorate of potash to the ounce of water may be used as a mouth wash. If the child is too young to use this itself, a swab may be made by tying absorbent cotton to a stick of proper dimensions, and this may be used to apply the solution,

employing a proper degree of friction. If the mouth is sore, it may be applied with a soft sterilized gauze—never use a soft tooth brush, it carries infection. The mouth may be occasionally washed out with the following preparation especially after eating:

℞—Borax,	30 grains.
Sodium bicarbonate,	1 dram.
Distilled water,	4 ounces.

Or the following may be substituted in its place:

℞—Boric acid.	
Potassium chlorate, of each	15 grains
Lemon juice,	½ ounce.
Glycerol,	6 drams.

Never give syrups or honey to a child.

If there are deep erosions of the mucous membrane, or ulcerative surfaces, it may be necessary to cauterize them, either with silver nitrate, pure phenol, or chromic acid crystals. The last named are preferable in instances in which they can be conveniently used. The cauterized places should be subsequently dressed with a solution of calendula.

The treatment of follicular, or ulcerative, stomatitis in adults does not materially differ from that in infants, except that more active measures may be used. The remedies may be proportionately increased in strength, and personal care insisted upon. The teeth should be thoroughly cleansed, and all broken or sharp edges removed. A soft tooth brush should be employed after every meal, only when a normal condition has been established, and with it should be prescribed some antiseptic wash. A two per cent solution of zinc chlorid may be used as a gargle. At night a spoonful of milk of magnesia should be taken into the mouth and rinsed about all the teeth, to be left upon them until the morning. Enough of good nourishing food should be given, and the patient should have plenty of pure air and sunshine.

In cases of thrush in infants that are badly or insufficiently nourished, there is usually more or less of gastric or intestinal irritation in connection with the markedly atonic condition. This will probably require the administration of such correctives as rhubarb and soda, or lime-water. When the aphthæ occure in older persons they are often spoken of as "canker spots," or "canker sore mouth." The usual treatment is roughly to cauterize the spots and dress them with a solution of calendula. If an active cauterant is not desirable, as in children, the aphthous patches may be repeatedly touched with the following solution:

℞—Sodium salicylate,	1 dram.
Distilled water,	6 drams.

Or in place of the preceding this may be used

℞—Borax,	45 grains.
Sodium salicylate,	75 grains.
Tinct. myrrh,	1 dram.
Distilled water,	½ ounce.

The chlorate of potassium solution is strongly recommended.

If the aphthæ exist in considerable numbers, they may demand the use of antiseptic mouth washes. If they are the consequence of a general anemic condition, tonics and alteratives are of course indicated. While they are peculiarly uncomfortable, the aphthæ have no serious pathological signification, except as they are indicative of an atonic condition.

DEPOSITS

Superficial deposits upon the teeth composed largely of inorganic precipitates have their origin from external sources, and most frequently are derived from the fluids of the mouth. In addition there are accumulations of organic detritus, as decomposing food, animal and vegetable; fermenting starches and sugars; advanced products of decomposition; waste and broken down epithelial cells from the mucous membrane, and myriads of benign and malignant micro-organisms. These combine to form a pasty and cheesy deposition, which is found about the cervical margins of the teeth and gums. This mass is not in the nature or form of a calcareous tartar, and is easily removed by the frequent and habitual use of the tooth brush and waxed dental floss. It is not always necessary to use a tooth powder every day, for once the teeth have been properly cleaned by the careful dentist, it becomes comparatively easy for the patient to keep the mouth free from this debris. It must be emphatically stipplated, however, that these products of decomposition should be daily removed by the patient. In addition, if necessary, the dentist should insist upon seeing his patient at frequent intervals until there shall have been established conditions that indicate a normal, healthy mouth.

No amount of filling and restoring of defective teeth will ever suffice to maintain a healthy mouth so much as the unremitting care and removal of these organic deposits. The elimination and prevention of caries is dependent upon the destruction of the microorganisms of decay, and the removal of their acid products which are so destructive to enamel and dentin. The action of these organic deposits is not always readily appreciated. The destructive effects of the acid products are apparent in the interproximal spaces and angles formed by overlapping teeth, or where teeth have been extracted leaving the space to be filled in by the unsupported teeth, which causes a tipping forward thereby forming triangular pockets which lodge food and debris. The enamel may be quite thin at the points of contact in the interproximal space and universally so, yet not show an active break in the continuity of the surface. This accounts for the apparent rapid destruction of the teeth, when in reality the destructive process has been going on for years.

Green stains are among the simpler deposits found upon the teeth of young children as well as adults, particularly in the region of the cervical margins. These stains are wholly superficial and vary in color from a dark green or bronze to yellow. They are not indicative of any special pathological disturbance, only insofar as they denote an undesirable condition in the oral secretions. Their early removal is advocated, because they are claimed to be from a disease producing fungus which, if neglected and allowed to remain, will penetrate the enamel, and so erode the surface as to form a series of granular pits which ultimately combine to form a distinct cavity.

Erosions of the enamel surfaces frequently have their inception through the agency of the green stain deposits, and wherever there is a congenital weakness in the enamel, as in faulty structure of the enamel prisms, having soft white spots of calcification immediately adjacent to the interglobular spaces of the dentin, then erosion and decalcification and rapid destruction of tooth substance quickly follow.

Other stains found upon teeth are those deposits caused by the excessive use of tobacco and tea, and sometimes from the use of medicines. Except from the unclean appearance produced by these latter stains, there appears to be no immediate injury to the enamel surfaces in consequence. It is important, however, that they should be removed; this may be done readily by touching the stained area with a small amount of tincture of iodin then scouring with English precipitated chalk. If the surface is eroded and roughened, it must be dressed down smoothly with cuttle bone, or fine Arkansas stone and finally polished with chalk.

The salivary calculus, and the calcareous accumulations being deposited about the neck and roots of teeth, cause recession of the gum tissue and inflammation of the peridental membrane; these are among the most important of the deposits, because the neglected accumulations induce diseases of the gums and adjacent tissues, and although local and superficial in deposition may be the precursor of more serious disturbances.

The salivary calculus is a deposit from the saliva. The calcium salts are held in solution through the agency of the carbon dioxid (CO_2) present in the newly elaborated saliva. This fluid is poured into the oral cavity where it encounters acids derived from a variety of sources, and is subjected to the action of the ferments from decomposing foods. The quantities of saliva are more or less variable; this is also true of the calcic salts contained in it. The carbon dioxid (CO_2) is held in a very unstable solution, and upon exposure to the oxygen of the air and contact with the acids in the mouth, derived from various sources, the carbon dioxid (CO_2) is liberated, the calcic con-

stituents lose their solubility, form precipitates upon the teeth, and give rise to what is commonly called salivary calculus or tartar. Combined with these calcium salts are products of organic decomposition, which cause the tartar to become a powerful irritant to the gum tissue, and induces inflammation in the contiguous tissues.

The deposition of salivary calculus is mainly in the region of the mouths of the salivary ducts, as Wharton's duct and the duct of Steno. The greater amount is liable to accumulate upon the lingual surfaces of the lower incisors, and opposite Steno's duct, upon the buccal surfaces of the upper molars.

One of the predisposing factors in the accumulation of large precipitates of tartar is found in the fungoid growths and deposits upon the teeth, made up largely of partially decomposed food and threads of the higher bacteria as the leptothrix or streptothrix actinomyces. The protoplasm of the filaments of these organisms breaks up into bacillus-like elements, and all combine to form an agglutinating mass, which holds the precipitates of calcium and becomes a nidus for a concretion. And although the mouth has been kept free from these organic bodies, it is possible to find a foundation for holding tartar deposits in the saliva itself, which is a mixed fluid derived from the secretions from the oral mucous, parotid, sublingual and submaxillary glands. These secretions are subject to considerable variation, both in physical as well as in chemical character. Ordinarily, saliva is a clear, viscid fluid, at times thin and watery and at other times thick and ropy. According to Michaels, it contains all the salts of the blood which are dialyzable through the salivary glands; this offers a fair index of the metabolic processes being carried on in the entire system. There are times when the viscid and tenacious quality of the saliva with its mucin constituents becomes dried upon the teeth, forming masses of sordes (Marshall); this, together with the debris of epithelial cells, mucous corpuscles and salivary corpuscles offers a favorable nidus for tartar deposits.

CHEMICAL COMPOSITION OF SALIVA

The chief constituents of a normal mixed saliva are ptyalin—a diastatic ferment—mucin, and the chlorids of sodium and potassium. In variable quantities traces of albumin, fat, potassium sulphocyanid, sulphates and phosphates of the alkalies and alkalin salts, as the calcic phosphates, calcic carbonates and oxid of iron may be found; occasionally also traces may be found in normal saliva of urea and ammonium nitrate. "The source of origin of the saliva that contains these chemical constituents is from the blood, or more correctly from the plasma, which

is filtered off from the circulating blood into the interstices of the glands, as of all living textures."

In reaction the saliva when first secreted is slightly alkalin. During fasting, although secreted alkalin, it soon becomes neutral. Tests of saliva with litmus paper frequently give an acid reaction, and this may be due to the elaboration of acids from foods, ferments and bacteria.

Tomes gives the daily average of the amount of saliva excreted from 800 to 1500 grams, approximately from three pints to a little less than a quart.

Lehmann has estimated the specific gravity of saliva in health as ranging from 1004 to 1006, and states also that there may be a rise as high as 1009 and a fall as low as 1002, without the evidence of any existing disease.

Frerichs* gives the following chemical composition of mixed saliva:

Water		994.10
Solids—		
Ptyalin	1.41	
Fat	0.07	
Epithelium and proteids (including serum-albumen, globulin, mucin, etc.)	2.13	
Salts:—		
Potassium sulphocyanate, Sodium phosphate, Calcium phosphate, Magnesium phosphate, Sodium chlorid, Potassium chlorid	2.29	5.9
		1000.00

The excretion of the parotid gland contains slightly more water than the secretion from the submaxillary and sublingual glands, and in consequence is less viscid. It is rich in ptyalin, but contains no mucin; its calcic constituents are the carbonate and phosphate, the latter existing in minute quantities. According to Hoppe-Seyler the inorganic elements yield about 0.34 per cent.†

The secretions of the sublingual and submaxillary glands are poor in ptyalin but rich in mucin; the sublingual contains the highest per cent. Carbonate and phosphate of calcium yield about equal proportions. These elements amount to about 0.43 per cent in the submaxillary secretion, but the percentage is not so high in the sublingual.

Mucin is derived largely from the mucous glands, and the organic and inorganic constituents average about twenty parts to one thousand.

Berzeleus estimates the composition of salivary calculus as follows:

* Kirkes' Handbook of Physiology, 1893, p. 295.
† Marshall Op. Dentistry, 523.

Phosphates of calcium and magnesium	79.0
Salivary mucus	12.5
Ptyalin	1.0
Animal matter soluble in HCl	7.5

Calcic deposits from whatever source should be removed, and inflammations of the gums and mucous membrane of the mouth irrespective of their origin must be relieved and resolved into healthy tissue. It does not necessarily follow that because we find large deposits of tartar upon the necks of the teeth that we have the disease of pyorrhea alveolaris. We have seen many patients whose teeth have been neglected, and who were innocent of the smallest effort on the part of a dentist in all their lives as to removal of the deposits, which were excessive, and to whom the use of a tooth brush was unknown, yet upon the careful removal of these deposits and orderly and habitual use of the brush the mouth was quickly restored to a healthy condition.

The deposits in some instances have been exceedingly thick, and upon the lingual surfaces of the lower anterior teeth an aggregation of successive layers has formed, that completely bound the teeth together as in a plaster cast. The encroachment, however, does not always extend very far below the gum, nor necessarily involve destruction of the peridental membrane. An early treatment of such conditions, to be described later, results in complete restoration without the accompaniment of the disease designated pyorrhea alveolaris.

SERUMAL DEPOSITS

It is not the purpose of this part of our work to treat exhaustively the various authoritative opinions as to the etiology of the serumal deposits. We shall consider, however, a few of them in so far as to present a general summary that will guide us in recognizing these deposits which call for special treatment in their removal. The subject has been considered more completely in the chapter on pyorrhea alveolaris.

Dr. John Marshall,* in 1891, said, "That the deposition of the concretions upon the roots of the teeth in those localities not easily reached by the saliva, or in which the presence of the saliva would be an impossibility, is due to the causes which produce the chalky formations found in the joints and fibrous tissues of gouty and rheumatic individuals."

Dr. G. V. Black has done considerable research work and has written an exhaustive paper, published in the American System of Dentistry, Vol. I, p. 953, wherein he speaks of a calcic inflammation and phagedenic pericementitis as an accompaniment of the tartar deposits upon the teeth in the region of the peridental membrane, and though he indicates his belief that the cause is wholly local, he also admits that a sanguinary

*Transactions American Med. Assoc., 1891.

deposit may be closely involved in its origin. He differentiates it as a destructive inflammation of the pericemental membrane, distinct from other inflammations of this tissue though possessing features in common with them. In summing up his estimate, he concludes that the disease is essentially one of the peridental membrane rather than of the alveolus, and the destruction of these two structures is so nearly synchronous that it becomes difficult to say which has gone first.

Dr. C. N. Pierce* gives the name ptyalogenic calcic pericementitis to the conditions wherein the teeth are involved with calcic deposits, indicating, as he believes, the origin of these deposits and other calculi as traceable to the saliva. We are not concerned particularly in this section of our paper with the cause so much as in adequately recognizing the conditions in the mouth that call for treatment, and the establishment of a sound oral hygiene.

W. C. Barrett† has summarized the theory of E. C. Kirk on the formation of serumal calculus as follows:

"The capacity of the blood stream for holding in solution the waste products of nitrogenous metabolism, the results of functional activity in the body, is determined by the alkalinity of the blood plasma. Any decrease in this diminishes its solvent power for these, and causes their precipitation in the tissues nourished by the blood stream. This lessened alkalinity may be general, affecting the whole sanguinary current, or it may be localized in certain tissues; in the latter case there will be a localized precipitation of the products of which uric acid is a type. Excessive work causes an increased blood supply to a part, and excessive oxidation and tissue waste, which in turn produce lessened alkalinity, or a tendency toward acidity. The ligamentous tissues are especially liable to conditions of this nature, and the peridental membrane, belonging to this category, is especially subject to affections of the character noted. Excessive work being put upon the investing membrane of any tooth, through malocclusion or by bad habits in mastication, by injuries from wedging, the application of ligatures, or other causes, the resulting hyperemia brings in its train overnutrition, localized diminished alkalinity, with the consequent deposition of urates."

We have thus considered those superficial deposits found upon the teeth having their origin from organic debris and the saliva; it remains to briefly differentiate those which form upon the roots of the teeth primarily, and are commonly designated sanguinary or serumal calculus. Its characteristic appearance is somewhat different from the salivary calculi, although these latter may, through a considerable period of suc-

*Am. Text Bk. Op. Dentistry, 2d Ed., p. 510.
†Oral Pathology and Practice: Barrett, p. 139.

cessive depositions, become in time a dense, black, smooth supragingival deposit, having incorporated through the agency of pigmentary matter; oxids from amalgam fillings, and the action of medicines, which may cause it to assume the external color and appearance of the serumal calculus.

The location of these deposits would indicate their entire independence in formation of the oral fluids, as they are found precipitated upon the periphery of a root that is not denuded when formed, and where there is no destruction of the gingival border. It is distinctly more irritating to the tissues than the smooth amorphous deposits from the salivary calculus, and this may be due to its position within the alveolar socket where it is preëminently a foreign body. The depositions are not in uniform amorphous masses, but as separate minute nodules, which cling tenaciously and are with considerable difficulty removed. Successive aggregations unite to form a mass that is hard and brittle, whose color is olive black or olive green. It is unlike the salivary calculus which may be readily detected, and is therefore easy of diagnosis, as it is hidden away within the socket, sometimes beyond a point of accessibility for its removal.

The removal of deposits, whether of salivary or serumal origin, demands the highest skill and care in the use of specially designed instruments for this operation. No hurried and indifferent service rendered the patient will ever restore the oral tissues to a normal condition; this result is obtained only by deliberate painstaking care, combined with intelligent work.

The selection of proper instruments must be determined not by any arbitrary rule, but according to the requirements of the operation to be performed, and the writer has obtained the best results from a composite set selected from the admirable instruments designed by Doctors Kirk, Darby-Perry, King, Marshall, Abbott, Harlan, Smith, S. S. White Manufacturing Company, and J. W. Ivory.

The instruments should be clean and sterilized, and everything about them suggestive of care. The patient should be comfortably seated, and the chair inclined and head-rest adjusted in order to have the mouth receive the largest amount of light possible. All napkins, large or small, must be fresh and clean. The larger napkin should be sufficient to protect the patient's clothing from flying particles and loose debris. Ordinarily the operator stands firmly on the right side of the patient with his left arm around the head-rest, and by this means is in a position to gently steady the head. Small rectangular pieces of sterilized gauze from four by four inches to five by five inches are most useful in receiving the soft deposits as they are spooned off. A small piece of gauze should be rolled and placed between the lower lip and gums

to prevent pressing the septic matter into the delicate membrane of the lips. The lips may become infected and considerable swelling be induced by lack of care on the part of the operator. In order to lessen this liability it may be necessary to prescribe a suitable mouth wash and special application of the tooth brush for a few days preceding the operation of removing the debris. Where conditions are abnormal, this precautionary treatment is of value in preventing further inflammation.

The left hand should hold the mouth mirror, which serves the double function as a tongue depressor and light reflector. The eye of the operator should always follow the scaling edges of the instrument as near as possible, and whether the movement is a drawing upward or pushing downward, the scaler should be so held and supported by the fourth and fifth fingers resting upon the adjacent teeth, that there shall be no danger of a slipping and plunging into the tissues of the gums. When a deposit has been definitely located and dislodged, it should be immediately removed and accounted for. It may be necessary to frequently syringe the tooth and membranes with a warm, antiseptic mouth wash in order to facilitate the complete elimination of all foreign irritants.

Whenever there are indicated deposits below the gingival margin, it is well first to remove carefully the superficial deposits upon the surfaces of the teeth above the membranous tissues; beginning at the central incisors and cautiously working round the arch to the third molars; each half of the mouth being treated successively until all the teeth have been scaled. The time necessary for this operation will depend somewhat upon the conditions presented, and it may be necessary to resume the operation at a future time. During this preliminary scaling, mental note should be made of the pockets formed between the roots where debris and calcic deposits accumulate; minute congestion of the gingiva; triangular spaces and irregularities as a result of inclined crowns, and any other factors predisposing and favorable to the accumulation of deposits, as cavities through caries; furrows between the cervical enamel and cementum; hypertrophied tissues; eroded cement fillings; rough and pitted gold fillings and surfaces; projecting amalgam and other fillings; improperly fitting clasps, artificial dentures and gold crowns. All supragingival surfaces should be most scrupulously scaled, cleaned and polished as a preliminary operation to further removal of the subgingival accumulations. It matters not who may be responsible for the old restorations, it is a necessity that the roughened fillings and surfaces be cleaned and polished.

Incidentally, the patient's attention may be directed to certain localities within the mouth where there is a special tendency for the retention of decomposing foods.

Subgingival deposits invariably induce distinct pathological conditions within adjacent membranes, and each tooth carrying upon its surfaces and roots these foreign bodies should be treated individually, until all trace and evidence of their presence has been removed.

The tenacity with which serumal deposits cling may call for the use of a softening agent, and a twenty per cent aqueous solution up to fifty per cent of trichloracetic acid may be used with beneficial results. The percentage strength of the acid necessary is to be determined by trial. The acid is carried into the region of the deposit, either upon a wedge-shaped piece of orange wood stick or upon a few fibers of cotton soaked in the acid. A gentle pumping motion will suffice to reach the nodular deposits. Lactic acid has been recommended for the same purpose with claims for its therapeutic value.

The chiseling and scaling and applications of the acid may be repeated until all the nodules are removed, and the roots are clean and smooth. Care must be exercised not to lacerate the tissue of the gums and peridental membrane. The force employed should be well under the control of the operator to avoid destruction of the cementum, and unnecessary loosening of the tooth. Too much movement of the tooth within the alveolar socket is liable to carry granules of calcific deposits and septic matter further into the pocket and tissues. Should the teeth be very loose, a temporary supporting splint, made of softened modeling compound, and applied to the labial surfaces of the teeth en masse, when the lingual surfaces are under treatment, will be an effective and agreeable support; the reverse application when the labial surfaces are treated. Frequent syringing with a warm antiseptic mouth wash, such as phenol sodique or peroxid of hydrogen (H_2O_2) three per cent solution, to remove debris is necessary.

The author counsels against a too early application of massaging of the gum tissues, because of the danger of incorporating within the tissue loose deposits that become a continual source of irritation. This operation may be deferred until later when all trace of inflammation has disappeared, and careful exploring reveals no deposits.

Ultimately, a weak solution of zinc chlorid may be worked into the pockets as a stimulating astrigent. New vitality may be induced, bringing new granulations to the alveolar edges by scraping with a bur or hoe excavator.

The treatment should end when all is clean, and there is an effusion of coagulable lymph, which should be left and not washed or wiped out, because at this point nature can accomplish much in the restorative process.

The dentist should determine for his patient how soon this operation should be repeated, and that will be governed by keeping a careful record of the status of the case with treatment and results for future reference.

CHAPTER VI

DENTAL CARIES

BY C. N. JOHNSON, M. A., L. D. S., D. D. S., M. D. S., F. A. C. D.

In a work like the present it is deemed unnecessary to go minutely into the pathology of this disease and yet it is well to consider somewhat carefully certain of the etiological factors which affect us vitally in operative dentistry. Every operator who attempts to save the natural teeth should have a reasonably clear conception of the cause or causes of caries, of its modus operandi, and the peculiar methods of its attacks. If he is thoroughly informed on these points he will be in a position to do better work thereby, and recognizing this the foremost men in the profession have always sought to inform themselves in regard to these matters.

Some of the theories of the past have been so wide of the mark that they are interesting only as milestones along the uphill road of scientific progress, while others, though crude and lacking in demonstrated data, are worthy of the greatest respect in the light of the most recent knowledge. Certain writers have held the theory that inflammation played a part in the breaking down of the tooth tissue, that the character of the tooth structure itself was the most significant thing connected with it, and that the disease progressed from within outward. Others thought that while the disease began upon the surface of the tooth and progressed inwardly it was due chiefly to the chemical reaction of the saliva, that in fact it was acid saliva which produced the decay. But it was inconceivable to think that the saliva ever became sufficiently acid to eat into a tooth in the manner in which we find caries progressing, or that the soft tissues could tolerate it if it did. Not only this but if the saliva did the work we would find the teeth attacked uniformly upon all surfaces bathed in saliva while as a clinical fact there are certain surfaces in which decay seldom or never has its initial point of entrance. Some of our close observers noted these things and away back as far as 1828 Robertson indicated that the carious process was due to the action of some agency occurring immediately at certain points where cavities were to begin, his idea being that it was caused by "decomposition." This theory was of course vague as to the real active agent of caries, but it was correct in the principle that it was localized at certain points and was not general in the fluids of the mouth. There was much conjecture about the whole question of

the active agent of caries till Professor W. D. Miller demonstrated in 1884, that it was due to the formation of acid brought about by micro-organic growth in the mouth. The findings of Miller have stood the test of investigation since then, and while there are many factors in the development of this disease which we do not yet quite understand, still they gave us the first real basis of scientific knowledge to work from.

In a somewhat close clinical observation of the behavior of caries, the variation in its manner of attack, and in its general modus operandi in different cases, it is hard to conceive that it is always brought about in the same way or that its progress is invariably governed by the same conditions. That an acid causes the solution of the tooth tissue seems settled, and that this acid is the product of micro-organisms is also an apparently accepted fact. But why is it that we find such a variation in the manifestations of the disease in different mouths, and even in different periods in the same mouth? We may find micro-organisms in all mouths—in fact the very micro-organism which Miller demonstrated would bring about decay, and decay which could not be distinguished from that occurring in teeth in the mouth—and yet there are some mouths in which decay never occurs, and in most mouths where it does occur there is a great variation in its virulency at different times.

It was formerly the prevalent idea that these variations were due to differences in the tooth structure, that one tooth was harder than another and would therefore withstand the attack of the carious agent better, and this impression was so strong in the profession that it finally communicated itself to the laity and is still firmly fixed in their minds. It is common to hear patients say that their teeth are so soft that it is almost impossible to save them, or on the other hand that they are growing harder so that they do not have so much trouble with them as formerly. This has been a most difficult fallacy to dislodge from the minds of the profession, and it has been the means of the loss of a very great number of teeth which otherwise might have been saved. The impression that the teeth are inherently so defective in structure that they are thereby peculiarly susceptible to the attack of caries is very disheartening, and it has led many patients to abandon any effort to save them and to allow them to go by default. This impression has too frequently been fostered by members of the profession, whose function as teachers of the public should have made them guard against such false and harmful doctrine.

It is now many years since the investigations of Dr. G. V. Black demonstrated conclusively that there is really little variation in the chemical constituents of the teeth of different individuals, and that what variation there is has little or nothing to do with the inception of dental caries. This came as almost a revolutionary statement at the time but

his findings have never been disproved. Neither do the teeth of individuals grow harder and softer in any such sense as would account for the variations we see in the same mouth in the tendency to decay at different periods. Teeth grow slightly harder as age advances but this change is exceedingly slow and not of a character to affect the manifestations of caries. This is readily understood when we recall the fact that the teeth are the most stable organs of the human body, and are not being constantly torn down and built up by waste and repair as are other tissues.

And yet the impression in the profession that some teeth were very much harder than others was a perfectly natural one, owing to the difference in behavior of teeth under cutting instruments. This difference could not escape the attention of the most careless observer. Some teeth crumble away under chisels, excavators and burs, as if composed mostly of chalk; while others resist the attack of steel instruments almost to the point of striking fire. This led to the impression of varying softness and hardness in the teeth, and quite naturally to the conviction that this had a direct bearing on the tendency to decay. But there is another reason to account for the difference in behavior of teeth under instrumentation, and it is in accordance with close clinical observation that these same so-called "soft" teeth sometimes remain in the mouth for life free from caries while the "hard" teeth as frequently decay. It simply resolves itself down to a question of environment—the conditions which surround the teeth—rather than to the organic structure or constituents of the teeth themselves.

The reason that teeth vary in their resistance to cutting instruments is limited almost wholly to the enamel and is due chiefly to the arrangement of the enamel rods. In some teeth the rods stand nearly parallel and radiate outward in regular order from the dentin in a comparatively straight line. It is noteworthy that in any enamel the cement-substance which holds the rods together is not very strong and the enamel is easily cleaved in line with the rods. It will thus be seen that straight-grained enamel like this will break down readily under instruments. But there is other enamel in which the rods pursue a wavy course, and a section of which looks something like the structure of a gnarled oak. When a chisel is directed against such enamel as this it meets the stout lateral resistance of the rods themselves and is broken down with exceeding difficulty.

But there is no enamel formed in the mouth of man which the acid of decay is not capable of dissolving if the conditions are favorable to its development, and so all enamel is alike subject to the attack of caries. This one difference may be noted that when decay has once begun it is reasonable to suppose that it will progress more rapidly in enamel where

the rods stand straight so that the acid can have ready entrance between them than it will in wavy enamel where the access is less easy, though this has no relation to the question of the liability of the teeth to the original inception of caries.

If, then, it is a matter of the conditions surrounding the teeth which chiefly influences this disease, it is imperative that we study these conditions somewhat carefully, and herein, be it said, lies the future hope of the profession in controlling and ultimately in preventing a disease which is acknowledged as being the most prevalent of all diseases of the human race. Had it been a question of the tooth structure there would have been small hope because we have learned that when once developed we cannot change that, but being a question of condition we may reasonably expect in time to so control the surrounding condition as to limit the disease.

First it is necessary to learn what the conditions are which influence the inception of decay. We have said that the micro-organism of caries may be found in all mouths; then the natural query is, why do we not find decay in all mouths? What is the particular agency which makes it possible for the micro-organism to bring about caries in one case, and impossible in another? Dr. J. Leon Williams, and Dr. G. V. Black called attention to what they considered an important factor in the institution of caries, viz., the formation of gelatinous plaques on the surfaces of the teeth. We know that there are certain micro-organisms which in the process of their development produce a material closely allied in appearance to gelatin, and these are called gelatin-forming micro-organisms. The micro-organism of caries is one of this class, and it was the opinion of Williams and Black that it is mainly through the agency of these plaques that cavities are formed.

It is of course known that an acid in order to dissolve enamel in the way we see it in the mouth must be a strong acid, and unless the micro-organisms have some protection under which to work, their acid would be diluted very quickly in the fluids of the mouth, and thus their destructive process be interfered with. It was therefore the idea of these investigators that it is by virtue of the protection given the micro-organisms through the formation of gelatinous plaques that the beginnings of decay are brought about. A film is formed on the surface of the enamel and under cover of this the micro-organism may produce its acid in concentrated form and attack the enamel undisturbed by external interference. In fact Dr. Williams has been able to make ground sections of teeth thin enough for microscopical examination, showing the film in place with the micro-organisms under it and decay beginning in the enamel. Of course, after a cavity has once been started the micro-organisms have a sheltered place in which to work and do not need this gelatinous protection, but

it is in the inception of caries that it plays an important role. This film is not soluble in the fluids of the mouth nor is it easily dislodged when firmly attached. No rinsing of the mouth with liquid will affect it, and it takes appreciable friction with a tooth brush to dislodge it. The saliva may therefore flow freely over its surface without disturbing it, and even the most potent of the mouth washes yet devised will not dissolve it.

In this view of the case it is concluded that the significant thing in dental caries is the formation of this film, and that it is really the controlling factor in the question of immunity and susceptibility. In some mouths the conditions seem favorable for the production of these plaques, in others not, and upon this the issue is turned. In referring to plaques it must be remembered that a distinction should be made between these gelatinous plaques and patches of inspissated mucus and greasy masses of material left adherent to the surface of enamel through neglect in caring for the teeth.

Dr. W. D. Miller in writing on this subject seemed to place less significance on the film than Williams and Black, and claimed that the case was not yet proven. He said that we may find these films freely in mouths where there is no decay, and that we may also find cavities without the presence of a film. In the latter instance he admitted that the absence of a film after a cavity has started is no evidence that it may not have been there in the beginning.

In point of fact we have had just sufficient knowledge on this subject to make it imperative that we have more. As has already been intimated the behavior of some cavities is so entirely different from that of others that it is hard to conceive that they are all influenced by the same factors, and it is hoped that further investigations along these lines will give us a broader view of the whole question, and clear up some of the points which at present seem somewhat clouded.

But what concerns us most at this time are the clinical manifestations of immunity and susceptibility as we meet them in our every day practice. A close observation of the phenomena of caries in the average susceptible mouth will disclose the fact that there are certain times when the disease is much more active than others. The periodicity of dental caries may be studied with much profit by the dentist, with the result that he is better equipped to manage the cases that come to him and more encouraged to persevere in the face of an apparently hopeless condition where the active agent of caries seems to be running rampant over the entire number of teeth in a given mouth.

It is very rare indeed that the progress of this disease goes on uninterruptedly to the destruction of all the teeth in a mouth even when no attempt is made to arrest it, and much rarer in the event of any effort

being put forth on the part of the dentist and the patient toward its control. That this is true is sufficiently evident from the large number of cases seen in practice where some of the teeth have been lost many years previously while the rest are being preserved with very little tendency to decay. The lesson of this is that if we can carry a case through a period of great liability to decay we may reasonably expect a period of immunity to come sooner or later and with this to aid us in our efforts we may confidently hope to save the teeth for a lifetime so far at least as decay is concerned.

One very significant fact in this connection is worthy of especial note—a fact embodying the greatest encouragement and carrying with it the highest incentive to persistent and painstaking effort on the part of the dentist. This is the assurance, established by a very close clinical observation in the study of cases extending over many years, that the period of immunity may be advanced very materially by proper dental service at the time of greatest susceptibility. In other words when a dentist is struggling with a discouraging case of caries, endeavoring to keep the teeth free from deposits and insisting that the patient does his part on this work, when he is filling cavities which develop with disheartening frequency and repairing fillings that have failed, he may be assured that the result of his efforts does not stop with the teeth he is operating on, but that in his attempt to suppress decay he is changing the conditions in this mouth and establishing a state of immunity which will eventually aid him materially in saving the teeth of his patient. With this view of the case no dentist should lightly yield up decaying teeth to the forceps, nor should he become discouraged however prevalent decay may be in the mouth. There are exceptions to all rules in practice, and there are some mouths in which the tendency to caries seems to persist for a disheartening length of time, but in the average case the results are so very gratifying that it is well worth the effort of both operator and patient to follow up a line of treatment tending to its suppression.

Recent investigations of such men as J. Sim Wallace, and H. P. Pickerill would seem to indicate that the matter of diet is a very important factor in controlling dental decay. Wallace after a close study of the effect of diet on dental decay emphasizes the necessity of a diet containing fibrous foods which stimulate efficient mastication; and sums up his observations by outlining two diets, one of which is supposed to inhibit decay and the other to encourage it. In his book "The Prevention of Dental Caries," page 32, he says:

Firstly, we shall refer to the kind of meals which do not produce caries:

Breakfast.—Fish, bacon, toast and butter, coffee and tea.

Luncheon.—Meat or poultry, potatoes, salad, baked bread, pudding, fresh fruit, water.

Supper.—Rusks, toast, or bread, rolls and butter, chicken or fish, an apple, tea or coffee.

Secondly, we may outline the kind of meals which induce dental caries:

Breakfast.—Porridge and milk, bread and marmalade. Then perhaps a supplementary breakfast a few hours after of a glass of milk and a sweet biscuit.

Luncheon.—Mashed potatoes and gravy, or minced meat, milk and pudding.

Supper.—Bread soaked in milk, or bread and jam, cocoa and cake, and a supplementary supper on going to bed of a glass of milk and biscuit, or just a "tiny piece of chocolate."

"On comparing these two different types of diet, we observe that one is of a kind which stimulates mastication and the last thing taken leaves the mouth clean, or at least free from carbohydrates, so that even when soft food is part of the meal the mouth will be physiologically clean at the end of the meal. The other type is intended to represent the other kind of meal which is calculated to lodge about the teeth and to ruin them in a few years by making efficient mastication and the self-cleansing of the mouth practically impossible, and by leaving the mouth sticking with fermentable carbohydrates and a virulent crop of acid-forming micro-organisms which have had their development encouraged by the previous meal."

Pickerill in his book "The Prevention of Dental Caries and Oral Sepsis," lays great stress on the advantage of articles of diet which may be classed as "Salivary Stimulants." To develop a condition of the saliva inimical to the incidence of caries it is necessary to use acids in the diet, a seemingly strange phenomenon but one apparently borne out by fact. He says:

"What is therefore to be advocated is that *all meals should contain a fair proportion of salivary excitants, and more important still, should both commence and end with some article of diet having an acid reaction.*"

This teaching of Professor Pickerill is almost revolutionary so far as popular opinion is concerned. It has always been the prevalent opinion that the eating of acid substances was detrimental to the teeth and yet Pickerill proves that the mastication of acid fruits puts the secretions of the mouth in the best possible condition to combat caries.

His suggestion as to diet is as follows:

Breakfast.—Porridge with salt may be used, followed by anything customary, fish, bacon, bread and butter, marmalade or jam, the latter should be of a distinctly acid flavor. Conclude with some form of fresh fruit, orange, apple, pineapple, banana, pear, plum, etc., preferably raw, but may be stewed.

Luncheon.—A radish or small portion of some acid fruit as an initial salivary stimulant, meat, with sauces, which are nearly all acid and serve as excellent salivary stimulants. Fruit (stewed) and fruit pudding or pie, made not too sweet, and fruit predominating over the starch element. Salad.

Tea.—May include as salivary stimulant, tomato, cucumber, cress, sardines, shrimps, fruit or sandwiches. Fruit salad or any fruit in season should terminate the meal.

Last thing at night children (and adults, too) should always eat a small portion of some detergent and acid fruit, such as orange, apple, pear, or pineapple. Tea and coffee, with cake, biscuits, etc., are not good as terminations to any meal. Milk, water, weak lime and lemon juice, slightly sweetened, are the beverages suited for children."

The testing out of all these theories requires time, but the efforts of earnest men all working to the same end must eventually result in a reasonable control of this disease.

The period of greatest susceptibility to dental caries is in youth, and it is here that our best endeavor in controlling decay should be put forth. If we can successfully save the teeth to the twenty-fifth year the worst of the difficulty is over, except that in mouths where there has been great susceptibility we may look for occasional relapses even where a condition of comparative immunity has been established. The circumstances which bring about these relapses are not always apparent and it is sometimes difficult to account for them. Anything which changes the conditions of the mouth may do it, such as a protracted illness, a change of climate which involves an entirely new environment, or any radical difference in the mode of life, or disturbance of the functional equilibrium of the individual. Severe mental stress is known to frequently induce an active recurrence of caries in a mouth which has for years been immune. But usually if a relapse comes it is easily controlled and not nearly so severe as the original attack.

This reference to the original attack, the relapses, and the periods of immunity does not imply that there is a sharp line of demarcation between them. An occasional cavity, or cavities, may develop at any time, but there is a very great difference between this and the awful havoc which we see so often occurring during periods of great susceptibility. Neither does it follow, when we get a set of teeth in good condition after susceptibility, that there will be no further need of dental service, even though the mouth should remain immune. Where decay has once manifested itself extensively in a mouth the teeth should have the supervision of a dentist at regular intervals afterward. There is always the necessity for hygienic treatment in the way of removing deposits and general prophylaxis, besides the repairs so frequently required in the operations performed during

susceptibility. In a delicate child during the growing period if the teeth decay rapidly it is not always possible to do permanent work, and we may carry the teeth to the twentieth or even twenty-fifth year and have the formation of new cavities practically stopped, but with the necessity before us of making more permanent operations as the other ones fail from time to time. It is always best, of course, to make permanent operations in the beginning if this is possible, but it is not always possible with some of the temperamental conditions we meet in practice.

To carry one of these young mouths through the susceptible period is often very trying but the result is well worth the effort. The plan of procedure should be about as follows: When a child is brought to the dentist with the teeth decaying rapidly there should be no half-hearted measures or perfunctory attention to the work. It is not merely a matter of filling cavities, though this of course should be done at once, and done as thoroughly as the circumstances will permit. But what is of equal consequence is that a campaign of prophylaxis be instituted with the definite aim of limiting the disease as far as possible in the future. The child should be schooled into a system of caring for the teeth by such an impressive lesson from the dentist that it cannot well go unheeded, and there should be a regular inspection of the teeth by the practitioner to see that proper care is being given them, and that normal function is maintained. The key-note to the whole situation is the alteration of existing conditions in the mouth, and while—as has already been intimated—we do not know all we should about the conditions which influence this disease, yet we are certain of one thing that the establishment of full functional activity is favorable to the limitation of the disease. To this end all teeth should be kept comfortable for mastication, and wherever we find evidences that mastication is not being properly performed we should discover the cause and remedy it. A close observer can always tell whether or not the teeth and gums are subjected to the amount of friction necessary for perfect mastication by noting the unpolished surfaces of the teeth and the hypertrophied and congested condition of the gums, and where it seems impossible to establish the habit of good mastication in any given case, or in any particular region of a mouth, the child should be instructed to make up the deficiency by friction of the brush for a stated period of time each day. The time should be set by the dentist, and the patient urged to brush by the watch. The friction of the brush moistened in cold water over the teeth and gums for three consecutive minutes twice a day will soon have a very appreciable effect in stimulating the tissues to healthy action, and in polishing the enamel smooth and bright.

Cavities should be filled as fast as they occur, the aim being to keep caries out of the mouth at all hazards. Sometimes the disease is so ram-

pant that it is difficult to maintain the courage of the patient, and yet such a case should be fought with all the energy and enthusiasm of the operator, to the end that he inspires the patient with the confidence of ultimate success. Such patients should be carefully schooled in the theory of an approaching immunity, and the operator who is in earnest in his management of the case may conscientiously promise this on the basis of what has been observed in a close clinical study of such cases. There is a reasonable expectancy that in ninety-nine cases out of one hundred the teeth can be saved if proper attention is given them, and the usual history is that even in a very susceptible mouth about the eighteenth or twentieth year the conditions begin to clear up and the hardest part of the contest is over.

It is true that teeth are sometimes neglected so that when the dentist is finally consulted—usually as the result of pain—the conditions are so bad as to be very discouraging, and yet there is no case so hopeless where sufficient of the tooth is left as a basis for a filling, inlay or crown that the dentist should let it go by default. It is the lack of an enthusiastic application on the part of the dentist, a failure to show forth an evident confidence in the possibility of saving the natural teeth, and the neglect to sufficiently emphasize the importance of retaining them that has led many patients both in youth and middle life to become unappreciative of their real value, and indifferent as to their care.

The dentist may not be able, as has already been intimated, with our present knowledge to treat the mouth medicinally so as to change a susceptible case to one of immunity, but he assuredly can by instituting the proper line of prophylactic and operative procedures so influence the conditions as to at least control the disease and ultimately save the teeth. Not only this but he can by pursuing the proper course in the management of these cases so advance the period of immunity from generation to generation as eventually to limit the disease and bring it under easy control. It is frequently noted now that even where the deciduous teeth are extensively affected, if proper attention is given to the case the conditions are so changed that there is little tendency to decay of the permanent teeth, and they may be saved without much demand for filling.

The future hope of the profession is in the study of conditions which exist in the mouth, and while the ability to properly perform operations is exceedingly important it is not more so than a close observation of the phenomena which influence disease and also which affect materially the outcome of our technical procedures. If we understand conditions we shall operate more skillfully, more intelligently, and the result of our work will redound to the greater credit of the profession and a more lasting benefit to those who place themselves under our care.

CHAPTER VII

THE EXAMINATION OF THE TEETH FOR CARIES

BY LEWIS E. FORD, D. D. S., F. A. C. D.

INTRODUCTION

In the field of dental diagnosis nothing appears to be pregnant with greater possibilities for the attainment of definite results in the prevention of diseases of the teeth and their various complications than the early detection of dental caries. To the examination of the hard tissues of the teeth, unfortunately in the past and to a considerable extent at the present time, not enough significance has been attached, and hence to this phase of dental diagnosis but a small share of the time actually required by it is devoted by the average practitioner of dentistry. This problem which has awakened a keen interest in the minds of students of preventive medicine and dentistry, is replete with prophylactic potentialities which augur for a progressive decrease in the incidence of dental caries.

Dental caries, the reader should realize, is a preventable disease in the vast majority of instances, but then only as the reward of unremitting surveillance on the part of the patient and dentist. The physical or instrumental examination of the teeth should be carried out at stated intervals and during childhood particularly, with a degree of frequency such as to preclude the unleashed progress of the disease. The old adage with reference to the relativity of values of prevention and cure is nowhere more applicable than here. An incipient cavity of caries if detected and treated according to the generally accepted methods of operative practice may never disturb its possessor; overlooked or allowed to remain untreated, it encompasses grave dangers not only in so far as the teeth are concerned but likewise in so far as the general welfare and health of the individual are concerned. The hasty examination of the teeth and the erroneous conclusions that must result therefrom is the reason for the existence of an appalling number of dental cripples and chronic invalids. To pass over an incipient caries is nothing short of a professional crime. The examination for caries of the average mouth containing the average complement of teeth is with the average dentist a matter of a few minutes. This cannot be otherwise than a very incomplete survey of the conditions of the hard tissues of such teeth. Each tooth should be given the undivided attention

of the examiner for the detection of breaks in the continuity of its surfaces and for areas predisposed to decay. No duty is the dentist called upon to perform deserving of greater painstaking effort than that involved in the detection of early caries. All of this applies with equal emphasis to the teeth of both dentitions, the deciduous and the permanent. In the case of the former it is the duty of the dentist to distribute among parents and guardians the information that will lead to the conservation of the deciduous organs. From the beginning of the eruption of the deciduous teeth, the child should be placed under competent dental inspection to avert the ravages of caries. Apart from the detrimental effect upon the physical and mental development of the child by the presence of carious teeth, it is hopeless to expect a fairly normal permanent dentition to follow in the wake of a defective deciduous set.

THE EXAMINATION ITSELF

The physical examination of the teeth for the detection of caries is very much the same in all cases. It is advisable to follow some system and once this is determined upon strict adherence to it is to be the undeviating rule. After placing the patient in a comfortable and accessible position for the examination which is to begin with the lower teeth, and adjusting the chair accordingly and with the towel in place, the operator should proceed at once to wash his hands thoroughly with warm water and a good grade of soap, brushing hands and fingernails most thoroughly. These acts of scrupulous cleanliness on the part of the dentist are essential from the standpoint of asepsis and general culture and create a favorable impression on the patient. It is recommended that the explorers and mouth mirrors, even though they may have been previously sterilized by boiling, be placed in a glass container on the bracket table holding either a solution of potassium permanganate, grains 11 to water ounces 4 or a 5 per cent solution of liquor cresolis compound. The actual examination, the physical exploration of all the surfaces of all the teeth in a most careful and detailed manner, should now begin and a word of caution as to the manner of approaching the task seems to the writer appropriate at this time. If it is evident, by a glance at the mouth, that caries has been rampant and that a comparatively large number of cavities will be found, the operator should with caution report his findings, particularly so in the case of highly nervous and sensitive patients. The degree of confidence that a patient eventually reposes upon the dentist is the result of the care and consideration displayed by the dentist upon a number of occasions and to a large extent the first interview is the determining factor. Not unusually patients are shocked and irretrievably frightened by the array of facts placed before

them, suddenly, concerning the condition of their teeth, and in despair and discouragement follow the line of least resistance and indefinitely postpone the much needed reparative work. A psychologic survey of the patient is at times almost as essential as a conscientious investigation of the condition of the teeth. The first examination cannot, in the very nature of things, be considered as the exhaustive and conclusive one that it should be eventually for the valid reason that the denture should be subjected to a most complete scaling and polishing series of operations. This is almost invariably a necessity. Once the field is cleared of all forms of soft and calcified deposits and removable enamel stains, conditions are revealed which otherwise would remain concealed for months or longer, jeopardizing the vitality of the pulp, and inviting serious complications in the periapical peridental membrane.

MODE OF PROCEDURE

A full set of explorers is desirable but not essential as a very complete examination may be carried out with those shown in Fig. 116. Various

FIG. 116.

mouth mirrors, unblemished by grinding wheels or stones, should be in the cabinet where they may be easily reached and alongside the explorers on the bracket table there should be placed mouth-mirrors Figs. 117 and 118, the former plain, the latter magnifying. Also there should be upon the bracket table aseptic absorbent cotton in a glass or nickel plated container. In recent years the glass aseptic cotton container has come into great favor and its adoption is recommended. Unwaxed floss silk is indispensable for a thorough examination and for this purpose the nickeled container shown at Fig. 119 is recommended. A pair of dressing pliers and one or two aseptic napkins of convenient size complete the instrument and accessory requirements for the examination.

Place a cotton roll on the lingual and one on the buccal in the lower right molar region, holding them in place by means of some device constructed for the purpose. The writer has found the so-called "third

hand" a most useful device to prevent the displacement of the cotton rolls, and hold the cheek and tongue out of the way. After adjusting and carrying the saliva ejector to place, the surfaces of the teeth should be thoroughly wiped to remove all saliva and mucous and then wiped again with a pellet of cotton saturated in alcohol; blasts of warm air from the electrically operated or simple hot air syringe will hasten the drying of the tooth surfaces.

It is recommended that the mechanical exploration begin at the median line and progress backwards. The object of the examination is to detect breaks in the continuity of the enamel caused by the decalcifying action of the acid end-product of carbohydrate fermentation. The areas of teeth in which, because of structural peculiarities, food becomes easily

Fig. 117.

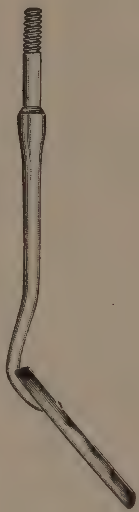


Fig. 118.

Fig. 119.

lodged are just the surfaces which should be most carefully scrutinized, namely, the occlusal surfaces of bicuspids and molars, the gingival thirds on the labial, buccal and lingual surfaces of all the teeth and the proximal surfaces of all the teeth. Every fissure should be slowly and carefully examined with any one of the explorers illustrated at Fig. 116, which will easily reach the surface under consideration. The operator's findings should be recorded on a chart of which there are various styles obtainable. Those cavities in need of immediate attention should be so recorded, as well as those suspicious areas that will require observation at a later date. The same procedure should be followed on the opposite side of the mouth and when completed, the chair should be raised and slightly tilted backward so that more direct light rays may be thrown upon the upper teeth. Again a cotton roll should be placed between the cheek and the buccal

surfaces of the molars, as was the case with the lowers, complete dryness of all the enamel surfaces should be secured. In the occlusal surfaces of bicuspids and molars the explorer will usually detect the beginning of caries, but in the proximal surfaces this instrument alone assumes limited usefulness. In these locations it is frequently impossible to detect caries with the explorer inasmuch as the area of destruction may be either at the contact point or immediately gingivally to it. It is here that the use of floss silk unwaxed is indicated and frequently the need for separating the teeth will become apparent. If the two proximal surfaces are intact, a length of floss silk when passed into the proximal spaces from the occlusal aspect of the teeth and out again should show no tearing or fraying. Transillumination with the electric mouth lamp is of value particularly when the contacts are broad. The lack of translucency of a carious cavity is marked as compared with that of the surrounding normal structures. Again the importance of having all tooth surfaces absolutely dry must be emphasized. In transilluminating for the detection of caries, the electric mouth lamp should be moved back and forth immediately behind the lingual aspect of the suspected teeth.

Radiography has come greatly to the aid of the dental diagnostician, and it is in connection with the examination of the mouth of particular value in the detection of incipient caries and of recurrent caries under fillings. The greater degree of radiolucency of an area invaded by caries as compared with the adjacent normal structure or the filling material is easily detected. In no other way may caries be discovered under a filling especially if the margins are but slightly affected.

The examination of the teeth for caries is as important as any service that the dentist may be called upon to render alike to patients, young or old. It demands careful attention to the minutest of details with reference to the unevenness of surface and changes in enamel translucency. A denture thoroughly scrutinized will fully reward dentist and patient, the former in the sense of a professional duty of the highest order conscientiously performed, the latter in future physical comfort and efficiency.

CHAPTER VIII

SEPARATION OF TEETH PREPARATORY TO OPERATING ON CAVITIES IN THE PROXIMAL SURFACES

BY LEWIS E. FORD, D. D. S., F. A. C. D.

When a cavity occurs in the proximal surface of a tooth it soon involves the contact point, and when this is involved the teeth begin to drop together and thus narrow the interproximal space between them. The narrowing of the interproximal space interferes with the normal form and condition of the gum septum, and in order to restore the proper form of the contact point and the interproximal space, it becomes necessary, before inserting fillings in these proximal cavities, to so separate the teeth that the correct contour may be given the filling and the full mesio-distal width of the tooth be restored. In no other way may the wedging of food between the teeth in mastication be prevented, and the normal condition of the gum tissue be maintained.

METHODS OF SEPARATING TEETH

There are two general methods of separating teeth preparatory to filling—the one by *gradual pressure* in advance of the operation by placing some material between the proximal surfaces of the teeth and allowing it to remain as a slow wedge; and the other by *immediate wedging* at the time of the operation.

The indications for gradual pressure relate to all cases where the element of time is not an important consideration. The lessened discomfort of this method, and the freedom from danger of doing damage to the teeth or supporting tissues by the sudden application of force, forms a very strong argument in its favor. Slow wedging is usually safer than rapid wedging, and more readily tolerated by the patient.

Materials for Gradual Pressure.—Various materials have been suggested for separating teeth, all of which have their advantages and disadvantages. Those most often used are India rubber, cotton, linen tape, and gutta percha. India rubber has been widely used in the past

because of the constant pressure exerted by it, and the efficacy with which it was therefore supposed to accomplish the purpose; but this materiai has one decided disadvantage which should limit its use to only a few cases. It has a tendency to slip rootwise of the contact point and work into the interproximal space, thus doing serious injury to the gum tissue, and failing in its object of separating the teeth. Unless this material can be so guarded as to hold it in its proper place it would better never be used. In fact, the cases are very few where it is indicated.

A pellet of cotton packed dry between the teeth will, when moist, expand so as to act as a very effective wedge, but this material cannot be left long in a cavity without becoming offensive, so its use is limited.

Linen tape about three millimeters in width is probably one of the most serviceable materials for separating teeth. It has usually been prepared by soaking it in hot wax to add to its firmness, but a better way is to incorporate chloro-percha in its meshes. A solution of gutta percha may be made by dissolving the ordinary pink base-plate gutta percha in chloroform, as is used in lubricating pulp canals, and then immersing the tape in this solution. When the chloro-percha is thoroughly incorporated, the tape is taken out and stretched on a table, and the two ends pinned to hold it taut until the chloroform has evaporated, which leaves a coating of gutta percha over all the meshes in the tape. This makes a material which is very tough and lasting, and which is not at all objectionable to the patient. After passing between the teeth it can be cut off, leaving a short end projecting lingually, and labially (or buccally as the case may be). These ends can then be pressed close to the embrasures between the teeth with a hot spatula, which leaves a wedge which will not in any way interfere with the tongue or lips or cheeks. It may be left in place for several days if necesssary and the wedging force is so gradual that there is usually no discomfort to the patient.

Another very satisfactory method of separating teeth is by the use of gutta percha, packed into the cavity and forced firmly against the tooth next in line. A gutta percha wedge of this kind will separate the teeth most effectively, and while the process is slow it is very sure and does not cause the least discomfort. Such a wedge may be left between the teeth for days, or even weeks, provided the decay is removed from the cavity and the dentin is saturated with one of the essential oils before the application of the gutta percha. If allowed to remain in a cavity for any length of time without removing the decay, the dentin is likely to become very sensitive.

In every instance where time will permit, the operator should use the gradual method of separation, but in an active practice many emergencies will arise which call for a more rapid application of force.

IMMEDIATE SEPARATION

In all those cases where space must be gained at the time of the operation the choice lies between a wooden wedge and a metal separator. The wooden wedge as a means of separating teeth is limited chiefly to those cases where there has been considerable recession of the gum in the interproximal space, and the teeth are more or less loose. The open interproximal space allows the application of the wedge without injury to the gum and the slight movement of the teeth permits of space by the use of the wedge without unreasonable force or discomfort. The wooden wedge is also useful as a means of holding the teeth firm during an operation where space has previously been gained by gradual separation. In such cases unless the teeth are held, there is always a tendency for them to drop together during the operation, and the space which has already been gained is lost. Not only this, but the manipulation of the teeth in operating tends to loosen them and make them sore, unless they are supported by a wedge.

An orangewood stick, such as may be procured from the dental supply houses for this purpose makes the most convenient and serviceable wedge. It should be whittled into a thin edge, and carefully forced by hand or driven by mallet into place, after which the projecting ends are cut off to get them out of the way.

THE METAL SEPARATOR

This appliance is one of the most useful and most dangerous we have in operative dentistry—the most useful if properly employed, and the most dangerous if carelessly or unskillfully applied. By its use space may frequently be gained at the time of the operation, doing away with the necessity of previous wedging. It is also useful in starting the teeth apart in those cases where a slow wedge is to be employed for gradual separation. The separator may be applied and the teeth lifted slightly apart, and the wedging material of cotton, tape or gutta percha placed between them to hold the space thus gained, and to gradually gain more after the separator is removed. This will hasten the process of separation quite materially.

The metal separator may also be used advantageously in place of the wooden wedge to hold the teeth firm during an operation, and maintain the space previously gained by slow wedging. It is very serviceable in this capacity.

The dangers of the metal separator relate to the possible damage that may be done to the supporting structures of the teeth as well as to the tooth tissue itself. If the separator is not carefully placed there is danger of the jaws impinging on the gum tissue, and if too great force is applied

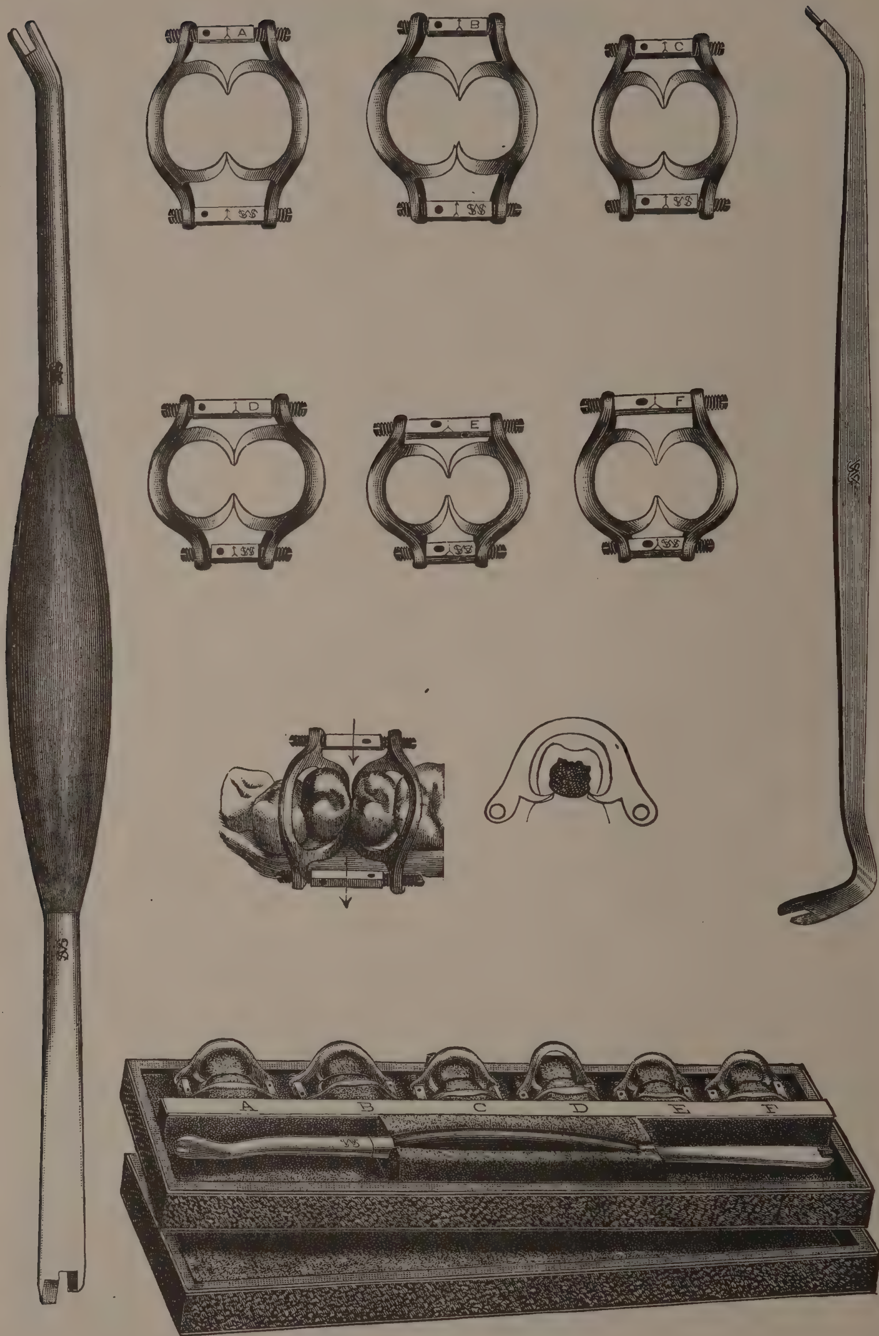


FIG. 120.—Perry Separators.

the pericemental membrane may be bruised so as to do it a permanent injury. Any unnecessary abuse of the tissues around the teeth should be avoided on account of the possible danger of starting pyorrhea pockets. Then the enamel may be injured if the jaws come too close to the edge of the cavity. Force applied by the jaws near the cavity margin may result in fracturing the enamel or pulverizing the rods so as to leave an injury at this point which will result in a leak around the filling. All of these dangers must be carefully guarded against if the separator is used with justification.

Kind of Separator.—The separators in most universal use today are the set devised by the late Dr. Safford G. Perry, and the adjustable Ivory separator. The Perry set is devised to meet all the requirements in the mouth, and consists of six instruments of varying forms for the different teeth. Fig. 120. They are very effective in their operation, and as humane as such appliances can ever be. With them every possible case of separation may be managed that lends itself logically to this operation.

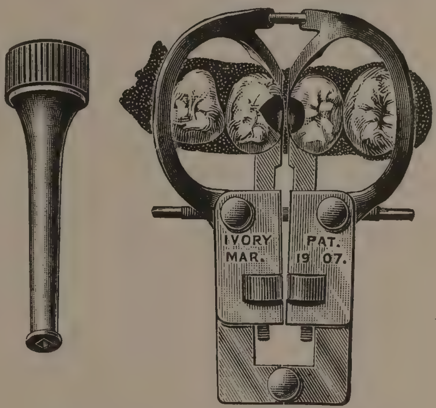


FIG. 121.—The Ivory Separator.

The Ivory separator (Fig. 121) is designed to meet all classes of cases in one instrument. As will be seen by the illustration, it is readily adjustable both as to the distance between the points of the beaks, and to the relation of one beak to another. Where economy is imperative this appliance will serve a very useful purpose, and will manage most of the cases very effectively, particularly in the anterior part of the mouth. On the molars far back it is not so readily applied as the Perry separator, and the operator who will serve his best interests will avail himself of the advantages of both kinds of separator.

METHOD OF USING SEPARATORS

The separator to accomplish the greatest service, and do the least harm must be used with the utmost care. The proper one for each given case should be carefully selected and skillfully adjusted. It should be applied at the beginning of the operation, and the beaks so placed that they will not impinge on the soft parts, or be brought too close to the cavity margin. The separator should be tightened just enough at first so the patient is conscious of it. Then work on the cavity should begin, and as

it proceeds the separator may from time to time be tightened a trifle to keep the tension constant, but not sufficiently severe to become distressing to the patient. The keynote of requirement in the use of the metal separator is gradual force so the tissues may adjust themselves to the new condition without undue discomfort or injury. Much of the prejudice against the separator has been brought about by injudicious or careless manipulation.

By the time the cavity is prepared it will usually be found that sufficient space has been gained without appreciable discomfort to enable the operator to begin the filling. As the filling proceeds more space may be gained by a gradual tightening of the screws, to the end that a proper contour is obtained on the filling, and adequate room for finishing is provided.

Two important considerations are imperative in manipulating the separator—the one is that in turning up the screws with the wrench the bows of the separator should be steadied by the other hand of the operator to prevent the least tilting or tipping of the appliance. This movement of the separator is likely to cause severe and unnecessary pain, and it is so easy to avoid it that this precaution should never be overlooked. The other is that when the operation is completed, and the time has come to remove the separator, the loosening of the screws should be done very gradually and not suddenly. There is no pain connected with the use of the separator quite so excruciating as that caused by the sudden loosening of the tension after the separator has been turned up to the limit. The tissues have been compressed and are under quite severe tension so that much of the blood is driven from the vessels of the pericemental membrane, and if this pressure is released suddenly, it causes a rush of blood back in the vessels which produces extreme pain. As the last touches are being put on the filling in its final polish the screw may be given an occasional turn without discomfort until the contact point on the filling rests against the contact point of the tooth adjacent to it, and is thus supported. The moment the tooth receives this support, there is no further movement of the teeth together, and the separator may be at once released. Used judiciously and skillfully the metal separator has a wide range of efficient service, but used carelessly it is one of the most painful and dangerous appliances ever placed in the hands of the dentist in connection with filling operations.

CHAPTER IX

EXCLUSION OF MOISTURE FROM THE FIELD OF OPERATION

BY FREDERIC RICH HENSHAW, D. D. S., F. A. C. D.

Many and various methods of excluding moisture from the field of operation about the teeth have been employed but the only absolute and perfect method is by the use of the rubber dam, which was given to the dental profession by Dr. Sanford C. Barnum in 1864.

Prior to the introduction of the rubber dam, comparative dryness was secured by the use of napkins, cotton, bibulous paper and other absorbent materials which necessarily confined all operations requiring the absence of saliva to short duration. The dexterity and skill exhibited by the dentist of those days in securing and maintaining a dry field would be a revelation to the modern dentist with his equipment of rubber dam, clamps, saliva ejector etc.

The Use of the Rubber Dam.—There are several reasons for the use of the rubber dam.

First.—Perfect dryness is essential to secure cohesion of gold and proper adaptation of other filling materials such as cement, silicates, amalgam and gutta percha to the cavity walls and margins, and for the elimination of debris caused by the burs or stones by means of the chip blower.

Second.—It provides a clear view of the entire field of operation as well as of the cavity, by holding the lips, cheeks and tongue out of the line of vision.

Third.—Moisture in a cavity distorts the view of the walls and angles, makes removal of carious matter uncertain and interferes generally with proper cavity preparation.

Fourth.—Sterilization of cavities and root canals can only be accomplished in a dry field, free from saliva or any other of the contents of the oral cavity.

Fifth.—The dentin in teeth having living pulps is much more sensitive when wet, therefore dryness will result in reduction of pain in the process of excavation and preparation.

Rubber Dam consists of thin sheets of strong, highly elastic rubber

and is to be had in three thicknesses which may be designated as heavy, medium and thin.

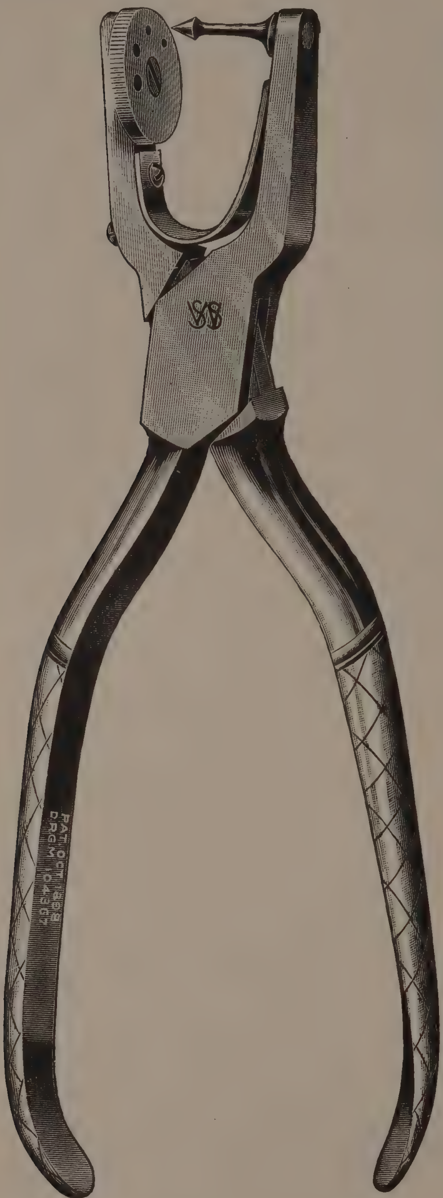


FIG. 121.—Rubber Dam Punch.

For practically all purposes a medium weight rubber will be found preferable, as a thick rubber dam does not lend itself so readily to adaptation to the teeth, while a very light one, though more easy of adjustment is much too likely to be torn by revolving instruments, such as burs, stones, disks, etc., or by the necessary stretching required to properly place it. A tear in the dam at a critical moment may endanger the results in many operations.

The color of the rubber is of no particular importance as the modern means of lighting the field of operation depends but little upon light reflected by the surface of the rubber, but most operators prefer a dark colored dam because of the contrast to the color of the teeth which makes it easier to guide them through the holes.

As with all rubber, deterioration occurs with age and exposure to light and air. It is therefore necessary that the roll be kept in an air tight container which will also serve to keep it clean.

The usual size of an individual dam is from 5 inches to 7 inches square in which are punched holes for the passage of the teeth to be isolated for any given operation.

The rubber dam punch illustrated by Fig. 121, is so constructed that by revolving the die plate, one of several sized holes may be cleanly punched, the size of the hole ranging from ¾ of a millimeter to 3 millimeters, being determined by the particular tooth to be encompassed.

Arrangement of Holes.—Necessarily there will be a very great deal of variation in the arrangement of the holes and the distance between them

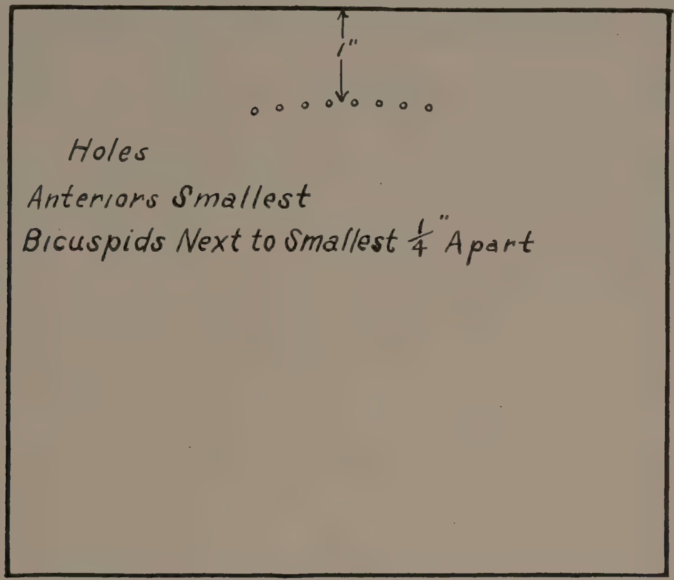


FIG. 122.—Upper Anteriors.

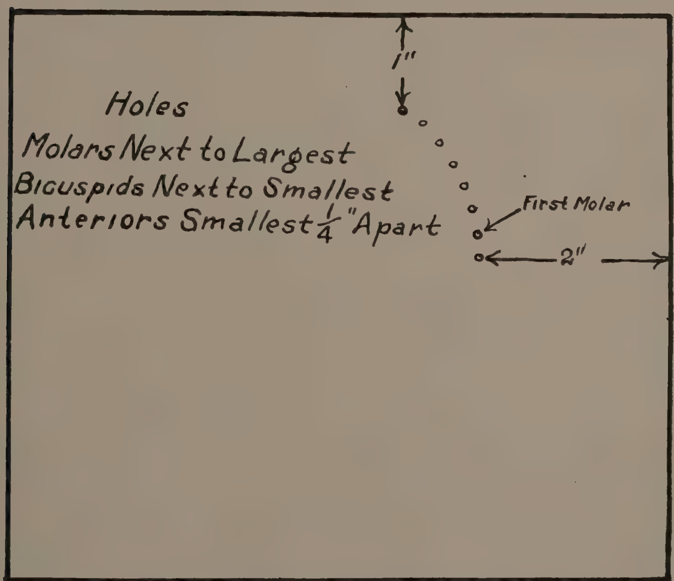


FIG. 123.—Upper Molars and Bicuspids.

because of irregularities, loss of teeth, etc., but the following graphic illustrations as perfected by Dr. Chas. E. Woodbury may be accepted as

pretty generally applicable in the arrangement and size of the holes, for a normal case, and from this may readily be worked out such variations as are necessary for any case.

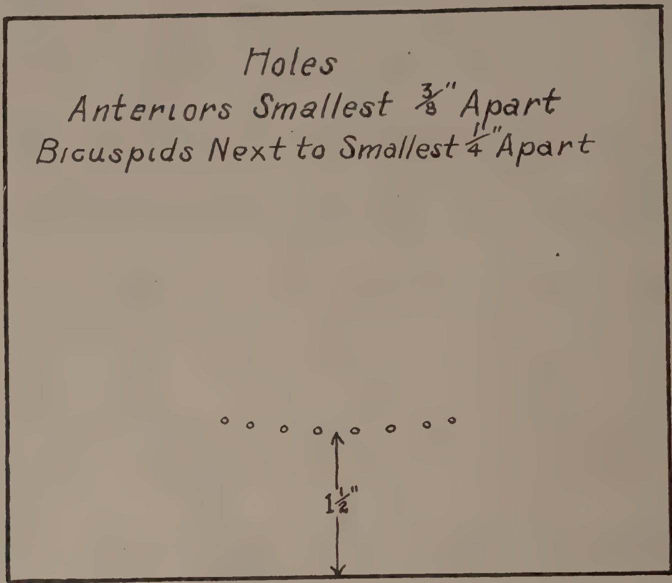


FIG. 124.—Lower Anterior.

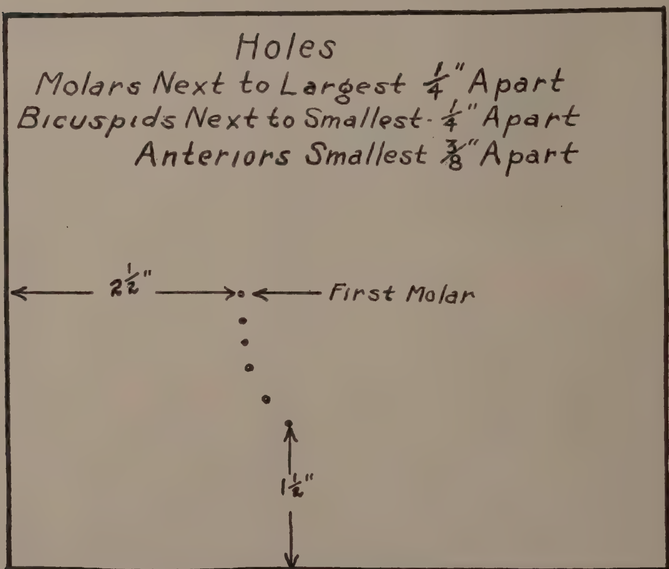


FIG. 125.—Lower Bicuspids.

In these charts which are drawn to one-half scale for a 6 inch by 7 inch piece of dam, Dr. Woodbury has given the arrangement, size and correct

distance apart for each hole, as well as the correct position in relation to the border of the dam, thereby allowing for the placing of the dam in correct relation to the mouth after it has been adjusted over the teeth, insuring complete coverage of the mouth and proper margins for attachment of the rubber dam holder.

A careful study of the charts will enable the student to avoid many blunders.

Variation will be necessary in those cases where the interproximal space is very wide or very narrow or in which certain teeth are malposed or malformed, or in which certain teeth are missing, the strait of rubber to lie between the teeth being governed in width by the case in hand.

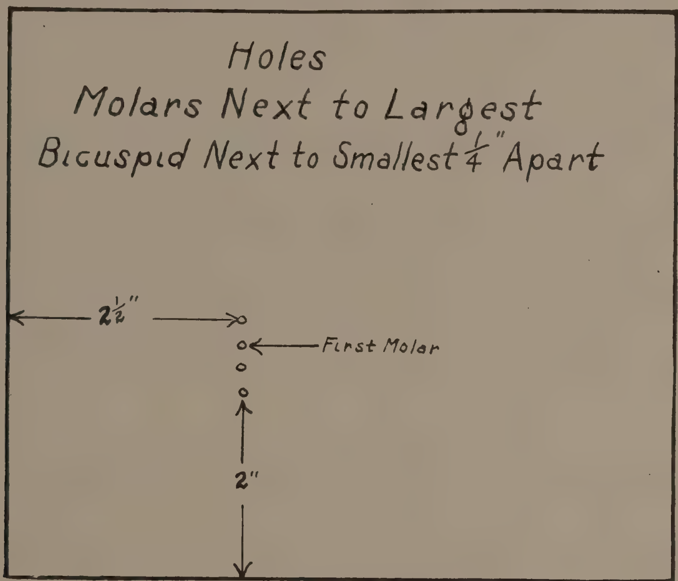


FIG. 126.—Lower Molars.

Number of Teeth Isolated.—The number of teeth isolated by the dam is a matter of very great importance. In certain abnormal cases in which much difficulty is experienced in carrying the dam properly to place about the necks of the teeth, because of abrasion of occlusal surfaces, malformation, etc., it may be necessary or desirable to limit the application to but two or three teeth but as a general rule it is advisable to include from four to six teeth. There is always more danger of having too few teeth included than too many, as each additional tooth exposed adds just so much to the field of operation and breadth of line of vision.

If the tooth to be operated upon is the first or second molar the dam should include the tooth distal to it, if possible, and extend forward to the median line, and if a bicuspid, the first molar should be included, as

this tooth permits the best possible use of the clamp. It is not well to stop at the cuspid, either in the upper or lower jaw as the anatomy of this tooth renders it very difficult to securely fix the dam at this point. For the same reason, when the lateral or central incisor is to be operated upon, the first bicuspid on the same side should always be included.

An excellent rule followed by many of our best operators is to include the eight anterior teeth for all operations on lateral and central incisors thereby providing the widest possible field for observation and operation.

Adjusting the Dam.—Before adjusting the dam the teeth should be given a thorough cleaning, as it is self evident that no tooth could be properly isolated if coated with calculus and debris. Raw, sharp edges of cavities or fillings should be smoothed and the spaces between the teeth to be included in the dam should be carefully examined by means of a waxed floss, making sure before hand that the rubber will pass readily between the teeth. It will frequently be found necessary to separate the teeth to be able to pass the silk between, especially in those cases in which the ends of the teeth and the contact points have been greatly worn, and in such cases a preliminary sitting may be imperative.

Wooden or rubber wedges applied for even a few minutes will frequently secure sufficient space for the passing of the ligature or, as suggested by Dr. C. N. Johnson, a thin flat-bladed instrument may be inserted between the teeth and carried rootward by a see-sawing motion, smoothing rough or jagged edges and providing for the safe passage of the rubber.

Before proceeding to adjust the rubber dam the mouth should be sprayed or rinsed with some good antiseptic solution and the gingival borders of all the teeth to be isolated should be swabbed with a 2 per cent solution of Argyrol or other antiseptic to relieve them of bacteria, thus preventing the carrying of infection beneath the free margin of the gum in the process of placing the dam.

The dam, having been punched for the particular case in hand, should be thoroughly washed in alcohol and the holes lubricated with vaselin, soap or warm cocoa butter to facilitate the passage of the teeth.

In all cases except those in which clamps are to be used on the posterior teeth as an aid to placing the rubber it will be found desirable to adjust the dam over the tooth nearest the operator, taking the others in succession. By so doing there will be less obstruction of the field of operation and less lost motion.

The dam should be stretched by grasping in the thumbs and fingers of both hands, the first tooth inserted in the hole and by a gentle see-saw motion the rubber carried down over the tooth until it reaches the cervix, the strait of rubber between the holes pressing down on the interproximal gum tissue.

Each tooth to be isolated is treated in a similar manner and in cases in which one or more molars are included it is best at this stage to apply a properly selected clamp by means of the clamp forceps. This will hold the rubber securely in place and the rubber dam holder can now be attached and adjusted, thus holding the rubber back and away from the teeth. Before proceeding further the dam should be raised from the lower lip and a folded napkin laid just over the lip line and carried up over the cheeks under the guard of the dam holder as a protection to the skin of the face, saliva moistened rubber being sometimes very irritant and always unpleasant.

Ligation.—It is not always necessary to ligate every tooth isolated in a given case and where this can be avoided it is desirable to do so. However the margins of rubber surrounding each tooth should be turned rootward to insure a saliva-tight joint. This may best be accomplished by the use of a round edged, flat or spatulate instrument, inserting it along the border and turning the rubber toward the gum margin, tucking it closely in against the neck of the tooth, or by carrying a waxed silk ligature between the teeth and employing gentle pressure at the cervix the dam may be neatly turned into place with little or no discomfort to the patient.

In some cases in which difficulty is experienced in forcing the rubber into the interproximal space it is necessary to draw the rubber into place with the waxed silk.

No more teeth should be ligated than is absolutely necessary but it is an excellent practice to ligate at least the tooth to be operated and, if the cavity is a proximal one, the tooth adjoining the side containing the cavity as well, as there is less likelihood of disturbing the dam during the operation when this is done.

Whenever it becomes necessary to place a ligature about a tooth, great care should be exercised in its adjustment as it may be a source of pain and even injury to the patient if handled carelessly.

Flat waxed floss silk is the best material for ligatures. In applying it to the tooth it should be firmly grasped by the fingers and thumb of each hand, allowing a space of about 1 inch between, and gently insinuated into the interproximal space, being careful not to permit it to suddenly slip into the embrasure. Having passed a loop around the tooth, bring the ends well up gingivally, and before drawing tight, insert a smooth curved instrument such as a pair of cotton pliers or Ash instrument number 10, beneath the loop on the lingual side, carry it below the gingival border, and apply traction to the ends of the ligature. The loop will slip down over the curved end of the instrument and come gently to place at the cervical constriction of the tooth with the least possible amount of pain.

Drawing the ends of the ligature tightly forward and rootward, make a

Surgeon's knot (Fig. 127) and tighten, being careful to hold the loop in place at the same time. A single knot tied on top of the Surgeon's knot will complete the tie. The free ends may be cut off close to the knot, or, as is practiced by some operators, may be carried out to the margin of the dam and tucked beneath it. In the case of the lower jaw they may be utilized for the attachment of small weights which assist in holding the lip away from the teeth.

In cases in which it is particularily desirable and necessary that no leakage occur either from the mouth into the field of operation or from the field of operation into the mouth, as root canal operations, bleaching of teeth, etc., a double ligation may be made by reversing the first passage of the loop, making a single or Surgeon's knot on the lingual surface, bringing the ends forward again, drawing the first knot tight at the cervical constriction and completing the ligation with a Surgeon's knot on the labial or buccal side, thus making a double ligature.

Fig. 127.—Surgeon's Knot.

In cases where it is difficult to prevent the ligature from slipping off the tooth because of its shape or due to the action of the muscles, small glass or metal beads or short bits of small rubber tubing may be threaded on the ligature and drawn down to the cervix on either side of the interproximal space. Drawing the ligature tight with these in place will materially assist in locking the rubber in its proper position. A pledget of cotton or a small wooden wedge forced gently into the interproximal space will often serve the same purpose.

Cleansing the Field of Operation.—After the dam is in place, it and the exposed surfaces of all the teeth should be thoroughly scrubbed with alcohol and dried with warm air. This not only cleanses the field of saliva and mucus, but by drying it, assists, materially in preventing the dam from slipping out of position. In case the operation is for pulp extirpation or root canal treatment, the whole area including the exposed teeth should first be swabbed with tincture of iodin and then washed with alcohol thereby rendering it sterile.

Before the student attempts the placing of a rubber dam in the mouth he should be required to practice the foregoing principles upon proper

dummies, studying the arrangement of the holes for given cases, tying of the ligatures, adjusting the clamps and acquiring the manual dexterity that is so essential in performing this necessary and sometimes difficult operation.

Clamps.—Rubber dam clamps are small spring instruments designed to hold the rubber in place on the bicuspid and molar teeth and to force

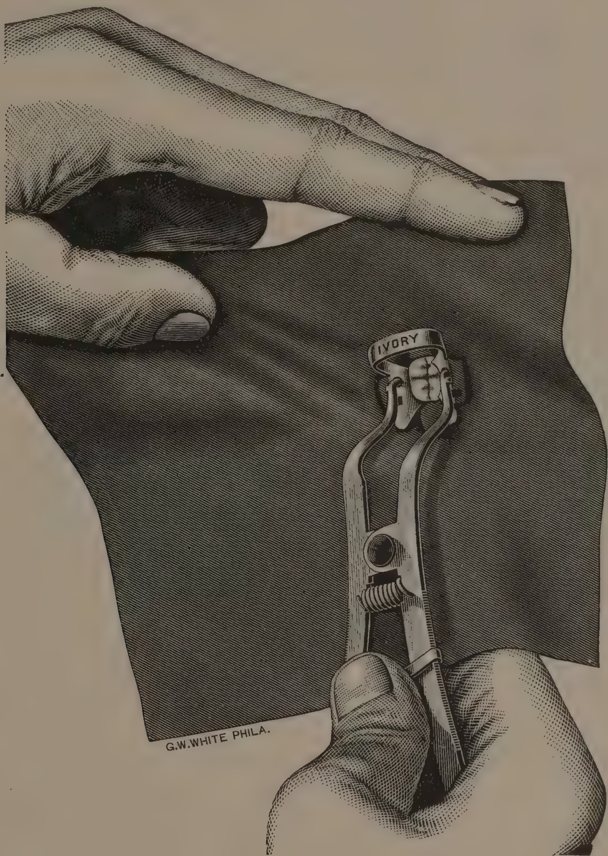


Fig. 128.—Clamp Forceps.

the rubber away from the margins of cavities at or below the gingival borders.

A few well selected clamps will suffice for any operator and as they are to be had in well standardized sets, no difficulty should be had in arriving at a proper selection. They are placed in their proper position by the aid of the clamp forceps as illustrated in (Fig. 128).

If properly selected and adjusted, clamps are harmless and comparatively free from discomfort but if carelessly handled or improperly fitted they may produce great pain as well as injury to the soft tissues.

Two forms of molars are especially difficult for the adjustment of clamps, those excessively bell crowned teeth, on which the clamp tends to slip rootward and injure the gum tissue, and those with exceedingly short crowns which seem to have no cervical constriction, where the clamp tends to slip off occlusally.

A perfect fitting clamp will usually solve these difficulties but there are many cases in which it would be far better to abandon the clamp entirely and depend on the ligature supplemented by the small beads as previously described.

Since the only function of the clamp on the molar or bicuspid is to securely hold the rubber in position and out of the way, they can usually be adapted to the tooth after the dam has been placed over it and where this is possible it should be done, because of the better view of the field that may be had by working from the anterior teeth backward. However,

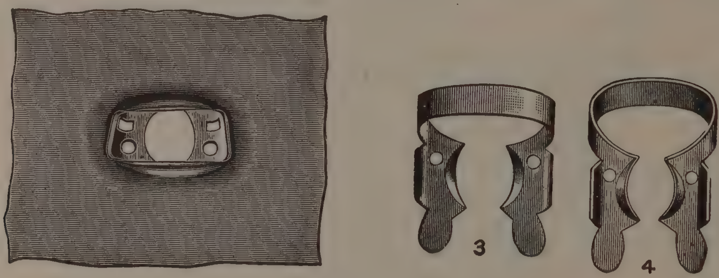


FIG. 129.—Ivory Flanged Clamps.

it will often happen that the dam cannot be carried successfully over the molars, especially in case of the lowers, and in such a case it will be necessary to proceed in a very different manner by beginning with the tooth farthest back and working forward.

Having selected a proper clamp (and for this purpose the Ivory flanged clamps are preferred Fig 129) the bow of the clamp is slipped through the last hole in the rubber, the edges of the hole being caught up on the flanges. The clamp with the rubber in this position is taken up by the forceps, the body of the dam folded up in the fingers and the clamp placed on the tooth, carrying the rubber with it. After the clamp has been released from the forceps in its proper position on the tooth the rubber is slipped off the flanges and falls to its proper place about the cervix.

The remaining teeth are then slipped through their proper holes in sequence and secured by ligation if necessary.

Perhaps the most trying cavities that fall to the lot of the dentist are those on the buccal and labial surfaces of the teeth, and in placing the rubber dam for restoration in these areas many difficulties must be surmounted.

Cervical Clamps.—Various devices have been produced to hold the rubber above the margins of cavities of this class, among which perhaps the most successful are the Hatch and the Ivory. (Figs. 130–131.) The Hatch clamp may be used on the upper teeth but is especially suited for the lower because of its simplicity and small size, while the Ivory is perfectly suited to the upper teeth.

In a large proportion of labial and buccal cavities the caries will be found to extend well beyond the free margin

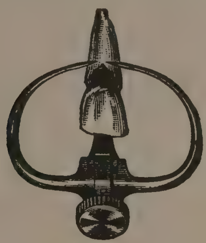


FIG. 130.—Hatch Cervical Clamp.

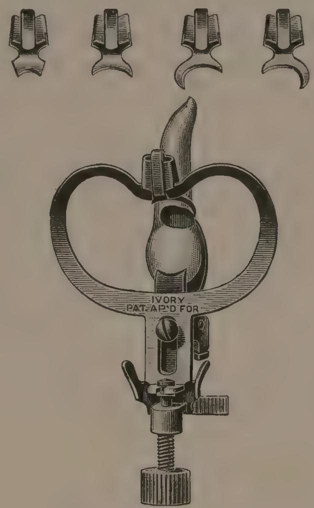


FIG. 131.—Ivory Cervical Clamp.

of the gum. It will frequently, if not generally, be found advisable to partially prepare these cavities at a first sitting, giving them a slight retentive form and then pack them with gutta percha, forcing it rootward so as to press the gum away from the cavity margins. At a subsequent sitting it will be found much easier to secure adaptation of the dam and clamp because of the cleaner field.

The application of a cervical clamp is always attended by severe pain and before adjusting it the gum tissue should be anesthetized with an injection of procain.

The dam should be adjusted in the usual way, no ligature being used on the tooth to be operated. If using the Ivory clamp the beaks should be adjusted to the proper position, the upper edge of the rubber at the hole lifted over the stud at the top of the upper bow and the clamp carried to place, pushing the gum tissue before it. When sufficiently high above the margin to give working space and vision it should be fastened tightly to place by means of the thumbscrew and the edge of the rubber lifted off the stud and allowed to settle into place about the exposed border.

In applying the Hatch clamp it is necessary to carry the rubber and soft tissue back at the same time by means of the two beaks pushing against them and in the use of this clamp, a previously tied ligature will often be an aid in carrying them to place.

Dr. Geo. Edwin Hunt summed up the use of clamps and ligatures as

follows: "In all cases where clamps and ligatures are used, as in all other steps in operations in the oral cavity, the comfort of the patient should be considered, and while the operator would grossly err in allowing his regard for the feelings of his patient to interfere with the perfect performance of the operation, it is often possible to save the patient annoyance and discomfort by the exercise of judgment and care."

Removal of Clamps and Rubber.—After an operation is concluded the operator should observe care in the removal of the rubber dam. Clamps should be carefully released and removed, ligatures cut with a sharp instrument and gently withdrawn, the rubber lifted away from the interproximal space and the straits passing between the teeth cut from hole to hole with small curved scissors.

This will entirely release the dam with no chance of any foreign substance such as a loop of rubber or a ligature being left about the teeth, as might easily happen if the dam were carelessly pulled from place.

Instances are recorded of a loop of rubber being torn from the dam by careless removal resulting in the ultimate loss of the tooth and of ligatures being allowed to remain in place resulting in serious damage because of irritation and inflammation.

After the removal of the dam the gums should be sprayed and gently massaged. They will quickly resume their normal state.

The Saliva Ejector.—One of the most essential adjuncts to the equipment of the dentist is the saliva ejector which is an instrument for sucking the saliva from the mouth by means of a vacuum created in a small tube by a water spray. This instrument is attached to the fountain cuspidor and consists of a metal or glass tube, curved at the end for insertion in the mouth, and of proper caliber for attachment to a rubber tube which extends to the valves controlling the water supply. These tubes can be sterilized by boiling and if made of glass should be kept in a jar containing a sufficient amount of water to cover them, to which should be added a few drops of hydrochloric acid. This solution will prevent the lime, to be found in all city water supplies, from being deposited upon the inside of the tube giving it a dirty, clouded appearance which is always objectionable to the patient.

The Use of Cotton Rolls, etc.—Many operators use the rubber dam too little, thereby defeating their efforts to properly care for their patients, and in the long run wasting valuable time that would be easily saved by having the field of operation exposed and dry and in fit condition for operation.

There are some occasions in which it may be absolutely impossible and even undesirable to apply the rubber dam, and in such cases recourse must be had to cotton, cotton rolls or napkins. Frequently in caring for children's teeth, particularily partly erupted molars, it may be found impossible to adjust the rubber dam. Cavities may also be found extending

so deeply beyond the gingival borders of the molars or bicuspids or interproximally so far rootward as to render it a physical impossibility to carry the rubber beyond the margins with any known device.

In such cases recourse must be had to cotton rolls which may be arranged in such manner as to dam back the flow of saliva from the parotid glands above, and from the submaxillary and sub-lingual glands in the floor of the mouth, and at the same time absorb at least a portion of that which does escape into the mouth.

Many designs of clamps have been suggested for use with cotton and cotton rolls, some so arranged as to prop the mouth open, and at the same time hold the cotton in place, but since operations of this character are necessarily of short duration and the mouth can be kept free from saliva by means of the saliva ejector it is hardly necessary to use anything except a mouth mirror to hold them in place.

Too much stress cannot be placed upon the necessity of using the rubber dam in all cases where it is possible to do so, better service to the patient being thereby assured.

CHAPTER X

PREPARATION OF CAVITIES FOR FILLINGS

BY A. E. WEBSTER, M. D., L. D. S., D. D. S., F. A. C. D.

Definition.—Under this heading is included all those operations which have for their purpose the removal of carious tooth tissue, formation of cavities for the reception and the retention of fillings and the extension of cavity walls to prevent further decay.

Nomenclature.—In every nation or class of people living and associating together is developed a system of signs or sounds by which ideas are communicated to each other. This is their language. In every business or trade or occupation there is similarly developed a system of signs, words and names which are used by those engaged in the same trade or occupation as a means of communication. These signs and names are termed the nomenclature of the trade or profession. Without such a code those in the same occupation would not be able to understand each other. So in the subject of the preparation of cavities it is necessary to have a system of names and signs which all must understand before communication is possible. The majority of the names used in the preparation of cavities will be familiar to those who have studied dental anatomy. Others will be defined. The nomenclature followed will be that adopted by the American Institute of Dental Pedagogics.

Cavity Nomenclature.—Cavities in teeth take the names of the surfaces of the teeth in which they occur.

Labial cavities occur in labial surfaces.

Buccal cavities occur in buccal surfaces.

Lingual cavities occur in lingual surfaces.

Occlusal cavities occur in occlusal surfaces.

Mesial cavities occur in the surfaces of the teeth looking toward the median line.

Distal cavities occur in the surfaces of the teeth looking away from the median line.

Proximal cavities are those which occur in the proximal surfaces of the teeth.

Cavities which involve more than one surface take the name of the two or more surfaces involved, thus:

Mesio-occlusal cavities involve both the mesial and the occlusal surfaces.

Disto-occlusal cavities involve both the distal and the occlusal surfaces.

Mesio-labial cavities involve both the mesial and the labial surfaces.

Mesio-lingual cavities involve both the mesial and the lingual surfaces.

Disto-lingual cavities involve both the distal and the lingual surfaces.

Mesio-occluso-distal cavities involve the mesial, occlusal and the distal surfaces. Other combinations may be made to describe the location of cavities.

CLASSIFICATION OF CAVITIES

Teeth usually begin to decay in defects of the enamel surface or on smooth surfaces not kept clean. Thus they may be divided into two general classes; pit and fissure cavities, and smooth surface cavities. Pit and fissure cavities do not require to be extended beyond the limits of decay or the defect in the enamel, while those on smooth surfaces usually require to be extended sufficiently to bring the margin of the filling to a point on the tooth's surface where it is kept clean either by the excursions of food or by the actions of the lips or tongue.

Pit and fissure cavities occur in the lingual surfaces of upper incisors and occasionally in cuspids, and in the occlusal surfaces of bicuspids and molars and the occlusal and middle thirds of the buccal and the lingual surfaces of molars.

The classification of cavities which follows requires a similar method of treatment for each class.

Pit and Fissure Cavities.—Cavities in the occlusal and middle thirds of buccal and lingual surfaces of molars.

Cavities in occlusal surfaces of bicuspids and molars and lingual surfaces of upper incisors and occasionally upper cuspids.

Smooth surface cavities occur in the surfaces not kept clean and may be classified as to location as follows:

1. Cavities in the gingival third of labial, buccal, and lingual surfaces.

2. Cavities in proximal surfaces of incisors and cuspids which do not involve the incisal angle.

3. Cavities in the proximal surfaces of incisors and cuspids which do involve the incisal angle.

4. Cavities in proximal surfaces of bicuspids and molars which do not involve the occlusal surface.

5. Cavities in the proximal surfaces of bicuspids and molars which do involve the occlusal surface.

NOMENCLATURE OF THE INTERNAL PARTS OF CAVITIES

The surrounding walls of a cavity take the names of those surfaces of the teeth toward which they are placed, thus an occlusal cavity has a mesial wall, a buccal wall, a distal wall, a lingual wall and a fifth wall which is known as the pulpal wall.

The pulpal wall of a cavity is that wall which is occlusal to the pulp and at right angles to the long axes of the tooth. If the pulp be removed the floor of the pulp chamber becomes a wall of the cavity and is known as the sub-pulpal wall. In cavities occurring in the axial surface that wall covering the pulp is called the axial wall and if the pulp be removed the wall takes the name of the wall of the pulp chamber. Cavities in the axial surfaces of teeth have mesial and distal, or buccal and lingual walls, and an occlusal and a gingival wall, and an axial wall.

In complex cavities which involve the axial and occlusal surfaces the gingival wall is termed the seat of the cavity and the pulpal wall is known as the step.

For purposes of convenient description cavities in teeth are supposed to be cuboid in form.

Where two walls join, a line angle is formed taking the name of the two walls entering into its formation, thus: Bucco-pulpal line angle or gingivo-axial line angle.

Where three walls join, a point angle is formed taking the name of the walls entering into its formation, thus: Gingivo-labio-axial point angle or gingivo-linguo-axial point angle.

The enamel wall of a cavity is that portion of the wall between the cavo-surface angle and the dento-enamel junction and includes the thickness of the enamel.

The dentin wall is that portion of a cavity which is lined with dentin.

The enamel margin includes the whole outline of the cavity and is equivalent to the marginal line of the cavity.

The cavo-surface angle of a cavity is the angle formed by the junction of the wall of the cavity with the surface of the tooth.

THE PLANES OF THE TEETH

The horizontal plane is at right angles to the long axis of the tooth.

Mesio-distal plane is parallel with the long axis and passes through the tooth from mesial to distal.

Bucco-lingual plane is parallel with the long axis and passes through the tooth from buccal to lingual.

The bevel of the cavo-surface angle is reckoned from the plane of the enamel wall.

DIVISIONS OF TEETH AND CAVITIES

For convenience of locating a cavity on the axial wall of a tooth the tooth may be divided into thirds, and known as the occlusal third, middle third and the gingival third. Cavities in teeth may be divided in the same way either in the horizontal plane or in the mesio-distal plane, thus: A buccal cavity is located in the gingival third in the horizontal plane, and in the middle third in the mesio-distal plane.

STEPS IN CAVITY FORMATION

The beginner in any mechanical work does not at once arrive at the best and most expeditious methods of procedure. But after a time if he be an observing person he will fall into an order of procedure which he will follow more or less rigidly. Hence it is important that he should at first at least follow those who have had opportunities of developing the best methods. The Institute of Dental Pedagogics has given the following steps in cavity formation as those fulfilling the greatest number of requirements.

1. Establish the outline of the cavity (outline form).
2. Remove the softened decay.
3. Give the cavity proper form. Which includes convenience form, resistance form and retentive form.
4. Bevel and polish the enamel wall.
5. The final touches or the toilet of the cavity should include a careful observation of the condition of the tooth tissue over the pulp and a thorough cleansing of the cavity surfaces.

General Consideration of Outline Form.—Before a dentist is justified in undertaking the treatment of a patient's teeth for the purpose of eradicating present caries and the prevention of future decay he should consider well all the factors which enter into the causation of decay and its prevention. The family history and the personal history of caries are of value in deciding the character of the operations to be performed.

Family Traits.—In some families even though there be many cavities while young, they yield to treatment and fillings have a degree of permanency not found in others of more favorable appearance. Then again caries in some families rarely appears before the fifteenth year while in others it begins at the appearance of the deciduous teeth. Caries will cease at the twentieth year in some families and not recur until

perhaps the fiftieth year or perhaps not at all. Patients giving a family history of immunity after a certain age and a personal history of immunity at the same age need not have what are sometimes called heroic operations done for them. The greatest attention in such cases should be given to the prevention of present decay rather than that which may occur in the future. Such conditions might influence to a large extent the location of the cavity margins.

Physical, Mental and Personal.—The physical, mental, and personal habits have a great influence on the character of operations that should be performed. Many patients apply for dental treatment who are not in a fit physical condition to have ideal dental operations performed. A dentist would be lacking in judgment who would ask a frail girl maturing into womanhood to submit to having the outline of many proximal cavities carried through sensitive tissue to bring them to a clearing margin. Then again there are those who are so weak mentally that it takes careful management to preserve their teeth at all. They think they cannot bear anything in the way of inconvenience. Such patients need the strong controlling force of a man who knows just how to handle them before he may venture to do ideal operations.

Natural Cleanliness.—Some patient's teeth are kept perfectly clean apparently without an effort. They eat proper foods and masticate them well, which is a factor in preventing caries. Almost all surfaces of the teeth are kept clean and are consequently immune to caries. If caries does occur the cavity margins do not require to be extended appreciably to meet areas which are immune. Others have teeth which always seem to have what might be called a scum over them, with cavities occurring in every defect of enamel and on surfaces which would be immune in other mouths. Where decay seems so progressive, cavity margins must be extended until they reach the immune areas of the tooth's surface even though much of the surface must be covered by filling.

Mouth Appearance.—The very appearance of the mouth often helps the operator to choose the character of operation. A certain viscid tenacious saliva, abundant in quantity, usually indicates rapid decay and demands that the outlines of the cavity should be extended far beyond the areas of contact with the other teeth. Many points of white or yellowish-white decay on smooth surfaces especially in labial, buccal, and lingual surfaces is indicative of a marked susceptibility and demands free extension of cavity outlines, while if the cavities be dark brown or black in color and are found only in fissures the outlines need not be extended so freely. Because of the difficulty of keeping irregular teeth clean cavities in such cases should be extended fully. It resolves itself into this, in all cases where decay occurs, that part of the tooth's

surface which is not kept clean about the cavity should be included within its outline.

1. *The outline form* is the form of the area of the tooth's surface to be included within the outline of enamel margins of the finished cavity. The first step in the preparation of any cavity is to decide as far as possible the extent of the caries which in a measure helps to locate the outline of the cavity. The extent of the caries helps to locate the outline only in simple pit cavities, and those occurring in exposed surfaces and those which are so large as to have involved all the defects of enamel and susceptible areas of the tooth's surface under consideration. To find out the extent of the caries it is necessary to break down the enamel not supported by dentin except perhaps where it may be left for esthetic reasons as in labial and buccal cavities in incisors, cuspids and bicuspids. The loosened and soft decay may be removed and the cavity washed out with a stream of tepid water. This will so clear the field of operation that a better judgment can be made as to the amount of sound tissue remaining, the condition of the pulp and the proper location of the outline. In the further preparation of the cavity it is well to have the rubber dam in position or use some other means of keeping the cavity dry.

(a) **In fissure cavities** the outline must include all the fissures and angular grooves radiating from the caries even though the cavity be but small. Such a cavity usually begins because of a defect in the continuity of the enamel surface and if only the carious portion be removed and a filling inserted the defective fissures remaining are just as likely to decay as originally. It is found that unless filling materials are polished flush with the enamel surface the thin edge left over the margins will likely be a point of leakage and later decay. If angular grooves are left radiating from a cavity it is impossible to so polish the filling that none will be left over these margins, hence it is better to cut them out and include them in the cavity.

(b) **Superficial defects** of the enamel about cavities should be cut out until sound enamel is reached and in some cases until full length rods are reached. In many cavities occurring about the gum margins there is an area of whitened or defective enamel passing around the tooth which if not cut out and included in the cavity will decay in a short time and cause the loss of the filling, and perhaps the confidence of the patient in filling operations. In some of these cases the outer ends of the rods are worn away or lost by the effects of superficial decay and are likely to cause the failure of the filling if the margin pass across it.

(c) **Extension for Prevention.**—The general rule laid down for locating the margins of cavities which occur in proximal surfaces is to extend them to such a point on the tooth's surface that the joint between the filling and

the enamel may be in immune areas. There may be some exceptions to this rule in rare cases but if cavity margins are allowed to come against adjoining teeth the fillings cannot be considered more than temporary.

Any one who has practised dentistry for more than a few years cannot help having observed the wisdom of extending all proximal cavities buccally, lingually, and gingivally far enough to bring the margins to such a point on the tooth's surface as will ensure their being kept clean or protected by healthy gum tissue. It makes but little difference whether the cavity be small or large in a proximal surface the outline should be well beyond any contact with the adjoining tooth. This extension of cavity walls through sound tissue to bring the margins to immune areas is known as extension for prevention.

(d) **A developmental groove or another cavity** should not be allowed to come too close to enamel margins. It is better in such cases to cut out the groove and include it in the cavity. The rods of the enamel in such cases usually stand at right angles to the surface which is faced away from the cavity, so when the cavity is prepared they are left without support. If only a small portion of enamel be left between a cavity and another filling it is almost certain to become a source of weakness to both fillings. Such enamel is usually more or less undercut and unsupported by dentin and the seat of fracture during the insertion of the gold.

(e) **The buccal and lingual margins** of proximal cavities in bicuspids and molars should be as nearly parallel as possible and at right angles to the seat of the cavity. Such a preparation makes the gingival wall more accessible to start and condense the first portion of the filling. Besides it brings the outline into full view during the building of the filling. If these margins and the walls of the cavity adjoining them are parallel the filling material as it is condensed will not draw away from the margins as in divergent walls, or tend to fracture the tooth as in convergent walls.

(f) The outline in all cavities should be *straight lines* or *regular curves* because it is much easier to adapt a filling material to a regular margin than to an irregular or ragged one. Besides they are said to be more esthetic, which is doubtful, but at all events they look more like the work of a good mechanic.

Technique.—To obtain the proper outline of a cavity it is necessary to break down and remove all enamel not supported by dentin. The straight chisel in the hand well guarded against slipping will cut away enamel readily if the edge of the blade is made to insinuate itself between the rods. The force should be applied in the direction of the long axis of the rods. In some cases the sharp edge of the blade may be placed against the wall of enamel and the edge snapped off piece by piece (Fig. 132). In others the edge of the chisel may be placed against the enamel and given

a quick decisive blow with a mallet which will readily fracture the enamel (Fig. 133). It is well to be careful not to attempt to cut off more at once than will easily be cleaved away on account of the shock from the mallet which may be painful to the patient and come with such suddenness as to cause doubt of the operator's skill. A chisel in the automatic mallet will often break enamel, but like hand pressure it is difficult to control. A chisel in an engine mallet will break enamel rapidly and is under control but violent on the patient if a blow is given against the enamel which does not chip off. The final planing of the enamel wall to bring it to evenness must be done with a chisel. Cavities in proximal surfaces which require extension through sound tissue are best enlarged by cutting the dentin out under the enamel with a comparatively small bur and then breaking down the enamel with the chisel.

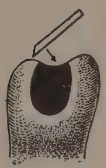


Fig. 132.

Fig. 133.

Cutting Out Fissures.—Fissure cavities can be extended in undecayed enamel by cutting a narrow slot through the groove with a small dentate fissure bur ground at the point on two sides to make it into a drill. A wornout, inverted cone bur ground to the same form will cut equally well. If the hand-piece be given a swaying motion and the point kept sharp even perfect enamel can be cut rapidly. If it be found that the dentin is not very sensitive the drill point may be directed rather under the enamel which seems to undermine it and allow it to cut easier. It is important that the drill be small, a large drill imparts too much jar to the tooth. Even the smallest size of an inverted cone bur so ground will serve every purpose because once the enamel is broken the edges may be chipped in with a chisel or a hatchet excavator. A small thin edged carborundum disk in the straight hand piece for bucco-lingual fissures and in the right angle for mesiodistal fissures will open them up rapidly and with less discomfort to the patient than fissure burs. In certain large distal cavities in molars the buccal and lingual walls cannot be reached with a straight chisel and a curved chisel with a narrow blade cannot be controlled if force enough be applied to fracture the enamel. The blade is almost certain to drop into the cavity and touch sensitive dentin or perhaps wound a living pulp. An instrument made on the form of a broad axe, with the blade short and wide and parallel with the long axis of the shaft will successfully break such enamel walls without danger to the pulp or the gum tissue.

In smooth surface cavities in exposed positions the outline may be extended with dentate inverted cone burs by placing the base of the cone against the axial wall and carrying the corner of the bur under the

enamel. In this way the foundation of the enamel is cut first leaving it easily cleaved away.

Final Trimming and Planing.—The final trimming or planing of the enamel wall is done with broad bladed chisels holding the width of the blade parallel with the long axis of the rods. Black's side instruments will shave the buccal and lingual enamel walls of molars, while the gingival is best reached with a Darby-Perry chisel. The enamel walls of pit and fissure cavities are best trimmed with fissure burs run rapidly and held at right angles to the pulpal wall. If access to the cavity is reasonably good, a thin carborundum disk will rapidly cut back the buccal and lingual walls and leave a smooth regular surface. A cone-shaped carborundum stone with a square end in the right angle will extend the dentin of both walls and square the seat at the same time.

2. *Softened and decalcified dentin should next be removed from the cavity.* In certain rare cases a portion of hard, discolored dentin may be left when its removal would expose a living pulp. In such cases a non-irritating disinfectant should be used for sufficient length of time to insure disinfection before the filling is inserted.

Technique.—The manner of removing the remaining decayed tissue depends upon the character of the tissue, the size and location of the cavity and the sensibility of the dentin. In shallow cavities in exposed surfaces where the dentin is usually sensitive a deep decisive cut with a hatchet excavator in one corner of the cavity, followed by prying up or scooping out of the tissue in one layer is less painful than to attempt to remove the tissue in small pieces. In large cavities when the decay reaches close to the pulp it is better to go around the edges with spoon excavators flaking up the decay and peeling the layers off without making much pressure. After the decayed tissue is well removed down to the solid dentin at all points except where the pulp comes nearest to the cavity, then take a large spoon excavator and carefully scrape away the decalcified dentin until hard tissue is reached. This can be done without pain to the patient if little or no pressure is applied. Usually in these cavities it is the dentin at the dento-enamel junction which is most sensitive. In certain cavities of dark brown or black decay where the tissue is hard, as occasionally occurs in occlusal cavities in molars in old patients, the decay may be most rapidly removed with burs. In no case should burs be used close to the pulp. In fact burs are of little or no value in removing decayed tissue except where it is hard. Spoon excavators are of most general use, though hatchets and burs may be used in special cases.

3. A cavity may be considered of proper form when it is so shaped that it can be conveniently filled, when it will retain the filling and when its walls will resist any stress which may come upon them.

(a) **For convenience** a cavity should be so formed that all its walls may be seen directly or brought into view with the mouth mirror. Grooves and undercuts should be avoided in a completed cavity form. They are always difficult to fill and add very little to the retention of the filling, and are a source of weakness to the walls. Line angles and point angles should not be so small and acute that instruments cannot reach their depths. Proximo-occlusal cavities in molars and bicuspids are in their most convenient form for filling when they are so shaped that they will retain the filling and resist the stress of mastication. If such cavities have a flat seat and step, parallel buccal and lingual walls and a dovetail in the occlusal surface, they are then convenient to fill with whatever material is desired. Cavities in incisors and cuspids require perhaps some slight modification of a gingivo-labio-axial point angle and gingivo-linguo-axial point angle to make it possible to more conveniently start a gold filling. These angles are made more acute and the corner is cut more deeply than is necessary for retention. They may be truly called convenience angles. In some cavities difficult of access it is often more convenient to cut away a wall or to extend an outline so as to bring the walls into full view. The labial surfaces of incisors and cuspids should not be cut away for convenience of access to a small proximal cavity. In the majority of these cases it is better to separate the teeth until access can be had to properly prepare the cavity and insert the filling, while in other cases the lingual surface may be cut into for convenience of access.

Technique.—The general technique of obtaining the outline form having been described it is not necessary to discuss more than what is specially done for convenience. A cavity with a good outline is easily filled. In many cavities having penetrating decay it will often be more convenient to fill any irregularities or pits not used for retention with cement, leveling up the walls. Often a buccal plate of enamel in a mesio-occlusal cavity in an upper bicuspid is left for appearance sake though the dentin is gone from beneath it. The loss of the dentin leaves such a deep groove at the junction of the axial and buccal walls that it is very inconvenient and difficult to fill it with gold. In such cases it is much better to fill the grooves with cement and square up the buccal and lingual walls so that they may be parallel. For convenience of starting a cohesive gold filling in proximal cavities in incisors and cuspids a No. ½ or No. 1 inverted cone bur, which is held parallel with the long axis of the tooth as it is carried from labial to lingual to form a flat seat for a filling, may be swayed toward the labial as it is carried to the labio-gingivo-axial angle, and as the bur approaches the depth required it should be swayed to the lingual and carried slightly toward the incisal. By this movement a deep acute angle is cut which has the general direction of the greatest

amount of tooth tissue avoiding the pulp. This acute angle is in a like manner cut in the gingivo-linguo-axial angle. With acute angles cut in opposite walls in the seat of any cavity there should be no difficulty in starting a cohesive gold filling. These may be truly called convenience angles though they are large enough to assist in the retention of the filling. These angles are easily filled and securely hold the gold in position while more may be built upon it. The small pits drilled at random in the seat of the cavity as has been too often the practice are difficult to fill and not always secure when filled. There seems to be a growing tendency among operators who do not wish to expose gold on labial surfaces to cut the lingual surface freely away, making a dovetail in the enamel for retention. This is really a convenience form.

(b) **Resistance form** is that shape given a cavity intended to afford such a seat for the filling as will best enable it to withstand the stress brought upon it in mastication. Its importance depends upon the area of the surface of the filling exposed to occlusion, and the strength of the closure of the jaws. The general rule in foundation construction is to keep as nearly a flat base as possible. Foundations made to resist heavy weights and tipping stress are flat. A cone-shaped base in a pulpless bicuspid or molar decayed mesio-occluso-distally has often been the cause of a fracture of the root. In such cases the filling acts as a wedge, cleaving the weaker wall. The seat of occlusal cavities should be flat and at right angles to the stress coming upon it, likewise cavities in proximo-occlusal surfaces of molars and bicuspids should have a flat seat and step to resist the heavy stress of occlusion and the tipping stress which comes upon these fillings. It is not often realized by operators how much stress some fillings may be called upon to resist. In strong men a single molar may occasionally have a force of from two hundred to two hundred and fifty pounds applied to it. The closure of incisors of course is much less, but the anchorage for a filling in these teeth is less. The biting off of a crust of bread and its mastication will involve a pressure of from 100 to 150 lbs., while an ordinary beefsteak requires seventy-five pounds of pressure on an area the size of the human teeth to cut through it. In accidents of a piece of lead in canned goods, or shells or bones in flesh, a filling may receive the whole weight of the closure. Pulpless teeth, crowns and dentures have much less force applied to them than normal teeth. It would seem that when the pulp of a tooth is lost the pericemental membrane loses some of its power to resist pressure without injury. Hence fillings antagonizing with pulpless teeth crowns and dentures need not be so securely seated as those opposing sound teeth. In deciding what amount of seating a filling should require the force of the closure of the jaws must be well studied. Also the teeth antagonizing the filling

and the area of the filling exposed to occlusion. It is obvious that labial, buccal, lingual, and small proximal cavities in incisors and cuspids do not require to be securely seated because the surfaces of these fillings are not exposed to the forces of mastication. No one thing has done more for the stability of fillings than the study of the forces of the closure of the jaws and the introduction of proper methods of seating fillings to resist that force.

Technique.—The inverted cone bur, the fissure bur, the chisel, the hatchet and the hoe excavators are the only instruments which can be used to form a flat seat in cavities to resist the force coming upon the filling. Round burs and spoon excavators have no place in forming the seat of a cavity. The seat, the step, and the lateral walls must be definite, joining each other with right angles or acute angles. The seat in molar and bicuspid cavities may be cut flat from buccal to lingual and from the enamel margin to the axial wall with an inverted cone bur about one millimeter in diameter. As this bur is carried back and forth from buccal to lingual there is often some difficulty in keeping it from jumping out of the cavity, and perhaps winding up the septum of rubber dam between the teeth, or wounding the gum, or perhaps cutting dangerously near the pulp. The difficulty of holding a bur in such a position is increased with the increase of the size of the bur and also by placing it in the right-angled handpiece. If, after all the overhanging enamel is broken down and the softened decay removed, the Ivory or Hinicker matrix be adjusted, a bur can then be held in the base of the cavity without fear of accident in one direction at least. It is generally well to use a small bur, cutting the dentin only, and then cut away the enamel with Black's side instruments or Darby-Perry chisels. This will leave a wide flat seat. The step is usually partly formed with cement and as the last part of its formation an inverted cone but in the right angle may be carried over the whole step. The seat of incisor cavities is formed in the same way only using much smaller burs; about a half millimeter inverted cone is more suitable for laterals and some centrals.

(c) **Retention form** is that shape given a cavity which will prevent the filling from being dislodged. This is largely provided for in the resistance form and to some extent in the convenience form, but in certain cavities the filling might resist the direct stress upon it and yet be easily displaced with slight lateral force. Retention form is provided for in proximo-occlusal cavities in molars and bicuspids by a dovetail in the occlusal surface and by providing parallel walls or perhaps walls slightly undercut. Proximal cavities in incisors and cuspids which do not involve the incisal angle do not need more than a flat seat deepened at the gingivo-labio-axial and gingivo-linguo-axial angles, with a slight undercut at the

junction of the labial and lingual walls at the incisal. Cavities which involve the incisal angle should be provided with a step if much stress is to come upon the fillings. For many years operators have been chiefly concerned in the retention of fillings, only having regard to what might tip them from the cavity, not thinking that the greatest force in dislodging fillings is the direct stress of the closure of the jaws. The more fillings failed the more and the deeper were made the pits, grooves and undercuts. The pits did not contain enough filling material to have strength to resist the stress, and the grooves and undercuts often cut clear through the dentin, leaving only the enamel for retention which frequently fractured. The thoughtless operator has an idea that if he uses a large round bur in the center of the tooth making the cavity larger inside than at the margins the filling cannot get out. This might succeed if the enamel were not so friable when unsupported by sound dentin. The surest way to make a cavity which will retain a filling is to study carefully the forces which may come upon it to dislodge it. Estimate the strength of the cavity walls and then so shape the cavity that its seat or foundation will be opposite the stress applied and its retention cut in the direction of the greatest amount of dentin, and if undercuts are used place them in opposite walls of the cavity. In general the retention should be as near the point of stress as possible, and the area of the seat and step equal to the area of the filling exposed to the occlusion.

Technique.—A cavity is usually shaped to resist tipping stress with the same instruments as are used to make the resistance form. Occlusal cavities in molars and bicuspids require parallel walls, and at opposite points a slight undercut which can be made with the inverted cone bur as its shaft is held at right angles to the pulpal wall. The only force which might remove this filling would be a lifting force from the adhesion of some sticky substance such as taffy. Proximo-occlusal cavities in molars and bicuspids cannot be retained to any extent by grooves or undercuts. The dovetail in the occlusal surface which is easily cut with a cross cut fissure bur or inverted cone bur is all that is necessary. In some bicuspids retentive form may be obtained in the occlusal surface by deepening the step at the point farthest from the proximal cavity with an inverted cone bur slightly undercutting the buccal and lingual walls. Proximal cavities in incisors and cuspids may have grooves extending out from the point angles for retention. As the inverted cone bur is sunk into the angles it may be carried up the labial and lingual walls a short distance making a groove. In many of these cases an obtuse angle hatchet or hoe may be used to cut a definite angular groove in these walls. The retention towards the occlusal is best cut with a small contra-angled hatchet excavator. No. 27, S. S. W., is a very suitable size.

4. *The proper bevel and polish of the enamel wall* of a cavity is of prime importance because the premanency of the filling depends so much upon the joint between the filling and the tooth. A good working knowledge of the histology of the enamel is essential to obtain the correct bevel of the enamel wall at all points.

The enamel is composed of rods cemented together by a less dense substance than that composing the rods. In consequence of the cementing substance being less strong than the rods the structure is likely to cleave between the fibers. The rods are difficult to cut across or hard to wear down from their ends but easily split, if the cleaving force is in the direction of the long axis. This is of importance in breaking down enamel to open into a cavity. If a chisel be directed against the enamel so that the rods are split apart little force is required. The rods are more or less parallel in their outer half while in their inner half they are interlaced and tangled together. In some teeth the rods radiate from the dentin almost parallel, while in others they are wavy and are interlaced a great deal. It is this variation in the interlacing of the fibers that accounts for the difference in the degree of resistance enamel has for cutting instruments. It was formerly believed that enamel which was very resistant to cutting instruments was harder because it contained more lime salts than that which cut more easily. This was shown to be a fallacy by Dr. Black, who demonstrated that the so-called soft teeth had not less lime salts but seemed to be soft because the enamel rods were straight and consequently easily split apart, while the so-called hard teeth were merely hard because the fibers of enamel were interlaced and tangled together much like the fibers of wood in a pine knot, and any attempt to cleave them is difficult because no matter in what direction the attempt is made the rods must be cut across.

The direction of the enamel rods may be said to be from the center of the tooth to the surface. The rods are generally perpendicular to the surface, but there are many locations where they approach the surface at a decided inclination. At a line about the center of a molar or bicuspid the rods are perpendicular to the surface, but as the occlusal surface is reached the rods become more and more inclined toward the cusps where they become parallel with the long axis of the tooth and perpendicular to the tip of the cusp. Likewise as the gingival is reached the rods become more and more inclined toward the root. It is clear from these facts that a cavity in an axial surface coming close to the cusp or marginal ridge cannot have its occlusal wall perpendicular to the axial surface without leaving many enamel rods not supported by dentin. A decided bevel should be given enamel walls at these points which may make the filling material so thin that it may flare up from the margin. Any attempt to make an occlusal wall of a cavity close to the occlusal surface is fraught

with many chances of failure. It is usually advisable to cut through to, and include some of, the occlusal surface.

The enamel rods incline toward pits and fissures and as they pass from a fissure in the occlusal surface of a bicuspid or molar toward the cusps, the rods incline more and more until they are perpendicular to the tip of the cusp. Thus a groove or fissure which is not cut out very widely requires only parallel walls to protect its margins, while a cavity in the occlusal surface of a bicuspid which is cut widely enough to approach the cusps needs a good deal of bevel.

In incisors and cuspids a line around the crown at the junction of the gingival with the middle third will find the rods pretty generally perpendicular to the tooth's surface. But as the incisal is reached the inclination of the rods becomes greater and greater until they reach the cutting edge where they are parallel with the long axis of the tooth. The inclination in the incisal third is often as much as 30 to 40 degrees. In proximal surfaces the degree of inclination of the rods depends upon the abruptness with which these surfaces join the incisal edge. The more rounded the corner the more the rods are inclined toward the incisal. Thus on the distal surfaces of laterals the inclination is greater than on the mesial surface. Proximal cavities coming close to the incisal edge in these teeth require so much bevel to remove the short rods that the margin of the filling is endangered by being too thin.

Passing around the incisors and cuspids the rods are generally perpendicular except at the junction of the proximal and lingual surfaces, where the rods are inclined towards the marginal ridge and become rapidly inclined the opposite way on the lingual, and consequently when this ridge is approached it should be cut well back because the rods are not supported.

Cavity walls cut in the incisal surface of incisors and cuspids are well protected even though not brought down on the labial or lingual surfaces because of the inclination of the rods.

Since the enamel rods are not always parallel with each other nor always at right angles to the plane of the tooth's surface, and since all filling materials are not always of equal strength with the enamel, it is not advisable to make the cavo-surface angle a right angle. But instead the outer half of the enamel wall should be cut back until the angle formed by the junction of the enamel wall and the tooth's surface should be greater than a right angle. The number of degrees greater depends upon the inclination of the enamel rods, the friability of the enamel, the force to come against it and the kind of filling material to be used. Gold fillings have the greatest protecting power for enamel walls and are the most likely to cause fracture or crumbling

of the edge during insertion, consequently cavities prepared for the insertion of gold require more bevel than those prepared for amalgam or porcelain. Cavities prepared for gold, where much force may come upon the edges and the enamel is friable, require more bevel than cavities which occur in surfaces where less force may fall. Teachers and writers of operative dentistry have always said much on beveling enamel walls but rarely given the student any adequate idea of how much bevel a wall should receive. This idea is hard to impart in words unless accompanied with diagrams and a statement of the number of degrees. Every student has an idea of what a right angle is, and he knows when a cavo-surface angle is a right angle. Now if he will divide a right angle into sixteenths, eighths, sixths, and fourths he will have an idea what is meant when the bevel is to be 5 to 25 degrees. This means that the cavo-surface angle is 90 degrees plus the number of degrees of bevel (which is for example 25) or 115 degrees. As a rule when a lecture is given to a class of students on beveling enamel walls there will be many of them go to the extreme in bevels. This must be guarded against lest the filling material be too thin on the edge.

Technique.—Beveling and smoothing enamel walls require so much skill and deft manipulation that it is only after repeated trials in cases where the results can be examined with a large magnifying glass that an operator can be at all sure of results.

A disk is the most suitable instrument to bevel and polish enamel walls but unfortunately its range is limited. There are really but few cavity walls which can be reached at the proper angle with a disk. It will reach the labial, lingual and buccal enamel walls in large proximal cavities but not the gingival, and only occasionally the occlusal. The beginner is certain to round the cavo-surface angle with a disk unless he bears in mind that the disk must not be pressed against the wall, but must be held in position to cut the rods parallel with their long axis, allowing no wabbling of the hand-piece, mandrel or disk. When the rods are thus cut the hand-piece is held at the necessary angle to cut the bevel required. Often too much bevel is cut in large proximal cavities, by allowing the disk to go too close to the gingival wall. At the junction of the gingival wall with the proximal walls the rods are in such a direction that the disk cannot possibly reach them to give them the proper bevel. The gingival enamel wall must be trimmed and beveled with a bur or chisel. A disk in the right angle will reach enamel walls in molars and bicuspids to better advantage in many cases than the straight hand-piece.

The next most suitable instrument and the most universally applic-

able is the chisel. As the walls are planed down parallel with the long axis of the rods they may then be shaved down to the proper bevel. The instrument must be held firmly and not allowed to turn or catch and jump as it is carried along the enamel wall.

The bur is very universal in its application in trimming and beveling enamel walls but can never leave as smooth and uniform a margin as the disk. In all small cavities in pits and fissures, and in labial and lingual surface cavities it is the only instrument that can be used. In the majority of such cavities the walls are cut back with a bur as the cavity is being prepared. The bevel may be made with a straight cut fissure bur run rapidly. The gingival enamel wall in proximal cavities may be best trimmed with a round bur, and it is recommended by Johnson for trimming the walls in occlusal cavities in molars and bicuspids.

The strip has a very limited use in smoothing enamel walls. It may be used in proximal cavities in incisors which do not involve the incisal edge but extend well onto the labial and lingual surfaces. In this position a strip held tight and passed back and forth from labial to lingual without allowing it to be lapped around the tooth will smooth the margin as nothing else will.

5. *The toilet* or putting the final touches on the prepared cavity should include a close scrutiny of the condition of the tissue covering the pulp and removing any dust or chips which may have collected in the cavity.

If the cavity wall be at all close to the pulp it is well to go over it with a large, sharp spoon which will remove any remaining decalcified dentin. Some care is needful lest so much pressure be applied as will cause pain. It is usual to cover such a pulpal or axial wall with cement and then form this up as if it were a wall of dentin. The cavity may now be dried thoroughly from a blast of warm air which will remove loose chips, but if moisture has been allowed in the cavity some of the chips will be so attached to the walls and crevices that they will not be removed by a blast of warm air. In such cases a piece of dry cotton rubbed around the walls will loosen the debris and then it can be blown away. Alcohol is often used to assist in drying a cavity but in sensitive teeth the patient receives a shock from the rapid evaporation of the alcohol.

INSTRUMENTS

While it is of importance to know how to prepare a cavity it is of almost equal importance to know what instruments to use and how to use them. The study of instruments and how to use them is no small

part of the preparation to practice dentistry. We are known by our tools. A fifteen minutes' examination of a dentist's operating equipment should satisfy any one as to his standing as an operator. Our instruments are of such importance to us that they deserve much of our attention in selection, arrangement and keeping in order.

FIG. 134.

An instrument is divided into handle, shank, blade and cutting edge. (Fig. 134.)

The **handle** is that part which is grasped while the instrument is being used.

The **shank** is that part connecting the handle with the working point or cutting edge.

The **working point or cutting edge** is that part of the instrument which comes in contact with the material worked upon.

If the working point be flat and sharp the portion widened to bring out this form is called the blade.

For convenience of communication instruments are classified as excavators, pluggers, scalers, trimmers, separators, polishers, clamps, burs, drills, burnishers, etc. These names denote the purpose or the use of the instrument. If we wish to further describe an instrument we say "hatchet" or "spoon" excavator, "right angle," "contra angle," or "cow horn" plugger. These refer to the form of blade or shank.

Chisels which are used for cutting or chipping away enamel have their cutting edges at right angles to the shaft and are sharpened by cutting or grinding only one plane of the blade.

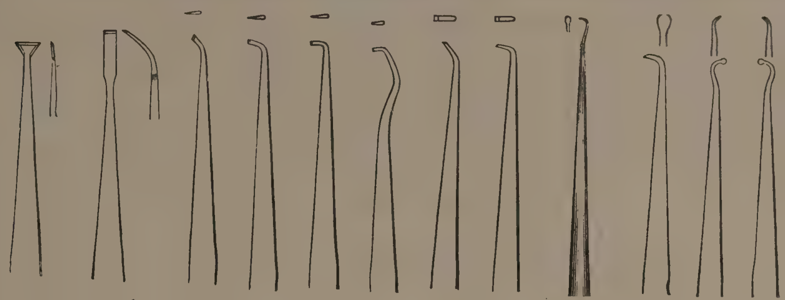
Hoes have the cutting edge at right angles to the shaft but the shank is so bent that the edge is looking towards the opposite end of the shaft, and the bevel to form the cutting edge is at the expense of that part of the blade away from the handle. They are used only with a drawing motion.

Hatchets have the cutting edge parallel with the long axis of the shaft and the cutting edge is formed by cutting or grinding both planes of the blade. The shanks are made at various angles to bring the edge within reach of the cavity walls.

Spoons are really not spoons in the true sense of the word. At one time they were made that they would dip up fluid but they are not now so made. There is no concavity in the blade. They have shanks of various curves to make the blades reach into the various depths of cavities. Spoons are, with the chisel, the most useful instruments in our equipment. They will remove softened decay to best advantage and will also cut decalcified dentin.

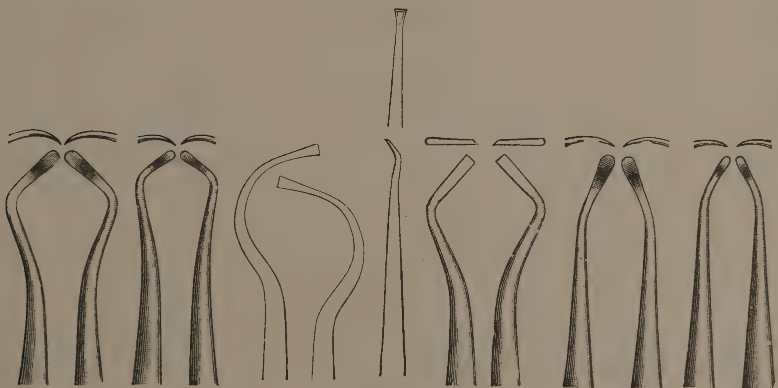
There are gingival margin trimmers and side instruments which are modifications of the chisel with shanks formed so as to bring the working edge into positions where the ordinary chisel will not reach.

While it is desirable to have every form and variety of instrument that will assist in any way in operating, it is at the same time desirable



FIGS. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146.

to have as few instruments as will fulfil the requirements. It will be found that the most useful instruments for all cavities in molars and bicuspids will be chisels, spoons and burs, while incisors will demand the small hatchets in addition.



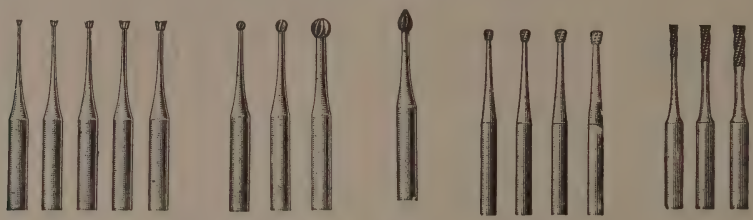
FIGS. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159.

Below is an equipment of cutting instruments sufficient to begin with and to fill most requirements. (Figs. 135 to 159.)

THE DENTAL ENGINE

The dental engine is classified as an instrument used in the preparation of cavities. While it may not be used to any extent in the preparation of a given cavity yet it is indispensable to the up-to-date operator. Other things being equal the operator who uses the dental engine the least will please his patients the most. The dental engine should

only be used for that part of the preparation of a cavity which cannot be conveniently done by hand. If such a rule were followed in practice patients would not dread dental operations. There are two general forms of engines which affect operations to a marked extent, the all cord engine and the flexible cable. The all cord engine carries the bur forward without any jar or shock, while the flexible cable usually winds up or springs back as pressure is brought upon the instrument, thus the bur is rotated with a series of stops and rapid turnings which jar the tooth and unnerve the patient. The all cord engine is not so convenient to reach difficult locations hence its want of popularity.



Figs. 160. 161. 162. 163. 164.

BURS

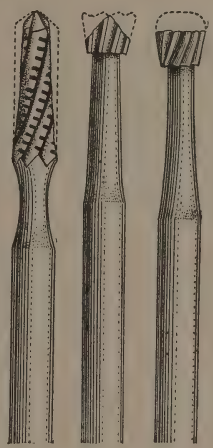
Only small burs should be used in the cable engine; those more than one and a half millimeters in diameter should not be used in teeth with living pulps or those with a sensitive peridental membrane. There are many forms of burs and drills used in cavity formation but the most useful is the inverted cone. (Fig. 160.) The round bur which has been used so extensively has no place in cutting that part of the cavity where a bur is indispensable. A bur should never be used to remove softened decay because spoon excavators will do it better. The round bur and the cone bur are useful to open into a pulp chamber when the pulp has been desensitized or devitalized. (See Figs. 161 and 162.) The form of the blades of a bur has something to do with the rapidity of its cutting. The dentate bur cuts enamel more rapidly than the plain blade. There is a dentate pear-shaped bur that cuts enamel better than any other form. (Fig. 163.)

The inverted cone bur has the great advantage of being capable of being made into other forms which are as useful as the original. Burs cannot be sharpened to make it pay at present prices but the operator can in a moment convert a dull bur into a most useful instrument for cutting out fissures or drilling out old fillings. A bur which has once cut enamel should never again be used to cut sensitive dentin. It has lost its keen edge. Burs should be arranged in the bur rack as new ones, those used on dentin a few times, those used on enamel and those only

useful to grind into drills, etc. Dull fissure burs can be flattened on opposite sides and the end sharpened into a drill point. (Fig. 165.) Dull inverted cone burs may be ground square across the end, thus cutting the blades off the end and bringing them far enough up the shaft to be sharp. This instrument will often cut out fissures as well as the original bur. It can be ground in this way until the blades are all ground off. (Fig. 166.) The old inverted cone may be ground into wedge or hatchet shape at the end (Fig. 167) and used to open up fissures, but such an instrument unless small gives the tooth quite a shock. It cuts better if the hand-piece is given a swaying motion.

SHARPENING OF INSTRUMENTS

No instrument which is intended to cut sensitive dentin should be used until it is first sharpened. Because a hatchet is new, it is no guarantee that it is sharp though it is likely to be. An Arkansas stone, on account of being fine and hard, is the most suitable for sharpening dental cutting instruments. If the stone is soft the fine instrument will sink into it, cutting it into gutters, or will catch and spoil the cutting edge. The stone should be wiped off with an oiled rag and thus kept free from particles of steel. After spoon excavators have been sharpened for some time on the Arkansas stone they develop what is called a thick edge and should be ground thin on a carborundum wheel, care being taken not to heat so fine a point while grinding it.



FIGS. 165. 166. 167.

The first attempts at sharpening chisels and hatchets may result in improper bevels, but some attention to this point will avoid the difficulty. A free back and forth movement of the hand will ensure best results. Spoons are the most difficult to sharpen. The motion should be back and forth on the stone, keeping the cutting edge parallel with the motion, and during each stroke the instrument is rotated so that every part of the edge will come against the stone during the motion.

PREPARATION OF PIT AND FISSURE CAVITIES

General Conditions.—Pit and fissure cavities are the result of defects in the enamel covering of the tooth, and are to be found in the occlusal surfaces of bicuspids and molars, lingual surfaces of incisors and occasionally in the occlusal third of the buccal surfaces of molars. The enamel begins to calcify at several points, the central incisor at three points, the

bicuspids and molars at the tips of the cusps. As the calcific matter is deposited the different lobes of enamel should join between the cusps, but this does not always happen, and as a consequence there is left a fissure which is a defect in the continuity of the surface and must be distinguished from a groove which is only a depression and not a defect. In teeth with very high cusps the fissures are often quite wide open. In fact they are sometimes so open in lower first molars that a fine explorer can be forced between the plates at almost any position along the depression between the cusps. It is a peculiar thing that often even such a wide fissure will not be the seat of caries while others of less width will decay. But the great majority of all fissures are the seat of caries sooner or later. The conditions are the most favorable for development of micro-organisms. Suitable material to develop upon is squeezed into these crevices during a meal and remains there only to be supplemented at intervals. If it were not for pits and fissures in teeth caries would rarely occur in occlusal surfaces, because they would be kept clean by the mastication of food. There is no better cleaner of the surfaces of the teeth than the chewing of hard tough foods.

Decay in pits and fissures is so often of a penetrating character that great care in examination is necessary. Even though a fine explorer will not enter between the plates of enamel there may be a large cavity beneath. In fact pulps are often reached by decay and pain be the first evidence that anything is wrong without any perceptible break in the enamel. In such cases a close observation will reveal a whitened area beneath the enamel along the fissure. Any change in the color of the enamel usually indicates some defect in the dentin beneath. If decay has once begun in a fissure there is only one treatment open to the operator. Cut it out in its entirety and include it in the cavity. Occasionally fissures may be found in recently erupted molars which have not begun to decay and may be prevented from doing so by drying them perfectly and squeezing them full of soft cement carried to place on the index finger and held there until the cement hardens. This treatment will often prevent such fissures from decaying in young patients where no other measures are available.

If every operator had the opportunity of seeing the micro-organisms of decay under a microscope and then seeing the width of the finest fissure under the same power there would be no doubt in his mind as to what should be done. Fissures are defects and are always a source of weakness and especially so when radiating from a cavity. Decay having once occurred in a fissure is an indication that it is susceptible, and even if the decay be all removed recurrence is almost certain if the fissures are not cut out to the end and included in the cavity. Besides cutting

out the fissures it is necessary to cut out angular grooves because it is impossible to properly finish a filling flush with the margin in these deep V-shaped spaces. If they are left they only form places for the lodgment of fruit seeds, etc.

Technique.—The first step in the preparation of pit cavities such as are found on the buccal surfaces of the first molars and the lingual surfaces of the upper incisors is to get access to the cavity. Since these cavities do not need their outlines increased to prevent further decay their preparation is quite simple. If the decay has not progressed to any extent they may be opened with a drill or a cone bur. Once a small bur will enter it is well to cut outwards rather than from without inwards. A larger and larger bur is used until free access is gained to the cavity. Usually there is not much soft decay in the cavity now under consideration so the inverted cone bur may be used to complete the preparation of the cavity. But if the pit has been the starting point of quite a large cavity the enamel can best be cut away with a chisel, the softened decay removed with spoon excavators and the cavity washed out with a stream of tepid water. If the rubber dam be now applied a full view of the cavity is possible and a decision as to the location of the outline arrived at. The enamel walls may be cut back with a good sized fissure bur, and the remainder of the decay removed with spoon excavators and a cement base inserted which will become the axial wall of the cavity. As the enamel rods around such cavities tend to lean towards the pit no bevel is required if the walls of the cavity are cut at right angles to the general plane of the enamel surrounding the cavity.

Occasionally a cavity in the lingual surface of the upper central or lateral may have a fissure extending from it quite through the singulum which complicates its preparation. The fissure usually runs clear to the limits of the enamel which in a young patient will be far under the gum. Such fissures must be cut out and included in the cavity. It may be necessary to pack the gum out of the way with gutta-percha. An inverted cone bur will cut out such a fissure more rapidly than any other instrument. Size ½ to ¾ mm.

A groove often extends occlusally from a pit cavity in the buccal surface of a molar but rarely needs to be extended over the ridge. If an occlusal cavity also exists it should be prepared before the buccal cavity is filled because when the two cavities are open at the same time a better judgment can be formed as to whether they should be joined or not.

The order of procedure in preparing fissure and pit cavities in the occlusal surfaces of bicuspids and molars is dependent upon the extent of the decay. If a shallow cavity has occurred in the central fossa of a molar which has fissures radiating from it the edges of unsupported enamel

may be broken down with a chisel and the outline form proceeded with at once. The fissures can be cut out with small inverted cone burs or those made into drills as described in a previous section. Once a small channel has been cut through a fissure the edges may be then broken down with a sharp chisel until the general outline has been obtained. An inverted cone bur or a sharp flat-ended fissure bur will cut out a flat seat and give the walls the proper form. If the cavity walls do not come close to the cusps the enamel wall needs no bevel. All that is necessary is to cut the walls at right angles to the pulpal wall. If there is now any decay left it may be removed with spoon excavators. If the pulpal wall has been cut with an inverted cone bur it will not be necessary to cut convenience angles nor will it be necessary to provide for any further retention than that cut with the inverted cone bur in forming the seat and walls. Clear the cavity of cuttings and it is ready to fill.

If a deep cavity has occurred, however, the operator is concerned with the possibility of the involvement of the pulp and the sensitiveness of the tissues from both decay and exposure to changes of temperature. It is necessary to determine the condition of the pulp as soon as possible because if it must be devitalized it should be done before there is any cutting of sensitive dentin in gaining the outline form. Cut away the unsupported enamel with a chisel, putting the guard finger on the tooth to be cut. Then remove the softened tissue with large spoon excavators, having a care for pressure. The spoon may be worked under the leathery decay at the edges and flake after flake removed without pain. Then wash out with tepid water. As soon as it is determined that the pulp is not to be devitalized there are two methods open, one is to now flood the remaining decay in the cavity with an anodyne which will prevent any pain from exposure and proceed with the outline form. Then remove the remaining decay and cover the pulpal wall with cement. In this method the deep sensitive tissues are not exposed for any length of time. The other method is to immediately deal with the deep parts of the cavity covering with cement and as soon as this hardens proceed with the outline form. By the latter method the sensitive tissues are dealt with early in the operation and are protected from thermal changes and the seat for the filling may be cut in the cement while the fissures are being drilled out. There is always a chance of finding some decay under the edge of the cement when the fissures are cut out. The final step in either method is to bevel the enamel walls which may be done with a round bur run rapidly or a fissure bur in the right angle held perpendicular to the pulpal wall and then in such locations as come close to the cusps the instrument should be held so as to give the wall a slight bevel.

A cavity in either of the occlusal pits of the upper bicuspids should when

completed include both pits and the connecting fissure or groove. It is very rare indeed that the tissue between these pits should be left if either have failed. It is not necessary to cut this fissure or groove more than one to one and a half mm. in width (Fig. 168). Cavities in the occlusal surface of the lower bicuspids need not be treated in the same way. In the majority of cases there is neither a fissure nor a groove joining the pits but a ridge of sound enamel, which should be rarely cut across because defects have occurred in either or both pits, unless, of course, the enamel has been undermined by caries. (Fig. 169.) There is a crescentic form

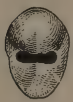


FIG. 168.


FIG. 169.


FIG. 170.

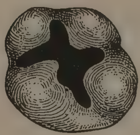


FIG. 171.


FIG. 172.

of the lower second bicuspid which if defective at all should be cut out in its entirety. (Fig. 170.)

Occlusal cavities in the pits and fissures of the upper molars depend in their outline form entirely upon the extent and direction of the fissures and angular grooves. A cavity in the central fossa of the upper first or second molar is usually simple in preparati on. There is often a question, however, as to how far to cut out grooves extending to the mesial or to the buccal. The general rule applies, cut all fissures and grooves until a good finishing margin can be obtained. Often it is advisable to cut the buccal


FIG. 173.


FIG. 174.

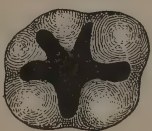


FIG. 175.

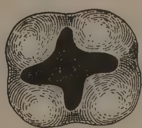


FIG. 176.

groove out until the break is reached to form the buccal surface. In such cases the extremity of the groove should be sloped into the center of the cavity giving a decided bevel to the wall. Thus a good finishing margin is reached without cutting a slot clear through to the buccal surface which would tend to weaken the cusps. Where there is a defect in both the central fossa and the disto-lingual groove it is always advisable to prepare both cavities at the same time when a decision can be made as to the advisability of cutting across the transverse ridge. If cut across it should appear as Fig. 171. If there is any thickness of dentin under the ridge it should not be cut across. (Fig. 172.) There is often a supplemental cusp

in the upper first molar which has grooves and fissures about it which must be cut out. These are often so penetrating that cusps are undermined and must be cut away thus facing almost the whole occlusal surface with the filling. (Fig. 173.)

Third molars are irregular in their markings but usually have three cusps, two buccal and one lingual, with a pit between and fissures running buccally, mesio-lingually and disto-lingually. Neither fissures nor grooves pass over the marginal ridges. (Fig. 174.)

Lower first molars have a central depression which is often defective and fissures and grooves extending buccally, lingually, mesially, and distally. These cavities are the most uniform of any under this heading. (Fig. 175.)

The lower third molars often have the same outline as the lower first, while the second will have the appearance of Fig. 176.

SMOOTH SURFACE CAVITIES

1. *Cavities in the gingival third of labial, buccal and lingual surfaces.*

General Considerations.—The number of cavities and the extent of caries in these locations is a true index to the care of the teeth. Cavities should not occur in these locations if our present views of the cause of caries be correct, that is if the patient takes reasonable care of his teeth. There is not a buccal or lingual surface except in cases of marked irregularity that cannot be reached with a tooth brush. It is safe to say to the patient who has such cavities that he does not brush his teeth properly and a lesson should be given to him at once. In the majority of these cases the first indication of beginning caries is a sensitive spot that the patient accidentally finds with his finger nail or a tooth pick. The area of the sensitiveness gradually increases until the tooth brush is not used even on that side of the mouth for fear of touching the sensitive spot. A break in the enamel occurs and extends both mesially and distally. This line is just at the junction of the free margin of the gum with the enamel where there is a slight protection from the action of the lips. These white lines of superficial decay rarely enter the proximal surface in young patients but usually do so in those of advanced years where the gums have receded to some extent. This decay never begins under the free margin of the gums but often extends there by undermining the enamel. In such cases the sharp edge of the cavity irritates the gum tissue, causing a hypertrophy which makes it appear as if caries had begun under the gum.

The proper treatment of labial, buccal, and lingual caries calls for careful consideration, not that fillings are often dislodged but that they so often fail at the margins. There is usually an area of defective enamel extending from the cavity and unless this is all cut out failure is certain

and even then the operation has not changed the environment. The future of fillings in these locations depends more upon the patient than upon the perfection of the operation. If after these locations on the teeth have been made comfortable the patient cannot be induced to regularly and carefully clean them no kind of operation other than the removal of the gingival third of the affected surface and covering the gingival margin with healthy gum tissue will last even a reasonable time. It is often a serious question how much of the enamel about such defects should be cut out and included in the cavity. The indication of the beginning of caries is a sensitive area. In such cases a thorough polishing with powdered pumice followed by chalk, with instructions to the patient to follow a simular treatment will often prevent the formation of a cavity. Since the general introduction of porcelain as a filling material labial cavities may be more freely cut for the prevention of future caries.

Though many labial, buccal and lingual cavities are difficult to manage there are a few where decay is slow and the tissue so non-sensitive that they are among the simplest operations that come under the dentist's care.

Technique.—The form to be given these cavities is simple but the management of the operation is exceptionally difficult, because of the hypersensitiveness of the dentin and even the enamel, and because of the difficulty of getting free access to the cavity. The gum tissue has usually grown into the cavity and is exceptionally sensitive as all pathological gum tissue is. And perhaps the greatest handicap of all is, the patient dreads the operation more than all others and the operator dreads it himself. Operations in these locations have a peculiar tendency to increase the flow of saliva which adds materially to the difficulty of the operation and to the discomfort of the patient. There are few operations in dentistry where the pain and discomfort to the patient are so out of control of the operator as a shallow sensitive cavity in the buccal surface of a lower molar in a nervous woman. The saliva flows freely, the ordinary therapeutic remedies cannot be used unless the rubber is applied and this cannot be done without a clamp which will certainly touch the sensitive area. Difficulties such as these can only be overcome by an experienced master hand. The hypodermic injection of novocain and adrenalin chloride into the gum opposite the end of the root promises results, while the injection of cocaine into the tooth with the high pressure syringe is more to be depended upon.

In the majority of small cavities even if the gum tissue has grown into them it is less painful and more expeditious not to make any attempt to remove the gum from the cavity until the operation can be made,

while in large and deep cavities where cotton and gutta-percha can be packed and retained without the removal of much of the decay it is wise to do so at a previous sitting. When the gum is removed from these deep cavities one of the difficulties has been overcome. In labial cavities the first step after using a solution of cocaine on the gum around the neck of the tooth is to apply the rubber dam. Dry the cavity. Break down the enamel around the cavity avoiding the decalcified dentin. Carefully plan the next step which will be the most important in the preparation of all such cavities. It is just as painful to remove one layer of the decalcified tissue as it is to remove the whole mass. If the cavity be small and no danger of pressing upon the pulp, select a location at the mesial or distal wall and sink a sharp hatchet or Darby-Perry spoon No. 9 or 10 down to the bottom of the decay and scoop the whole mass out at once. Just as this cut is undertaken the operator should warn his patient and at the same time divert his attention by remarks on some interesting topic. An application of hot phenol or phenol and alcohol will relieve the pain incident to the exposure of the dentin to the air. The further preparation of the cavity will not be more sensitive than any other unless it should reach the junction of the proximal surface with the labial about one mm. from the gum. An inverted cone bur in the direct hand-piece will cut a flat axial wall, and extend the other walls in any direction leaving sufficient undercut to start and retain the filling. Since the introduction of porcelain it is not necessary to discuss the peculiar forms of these cavities which make gold fillings the least conspicuous. The outline should extend under the free margin of the gum and when finished be covered with it. There should be such extension mesially and distally as will ensure sound, hard enamel. If any special convenience is required to start a gold filling it should be cut in that part of the cavity furthest from the operator and in the greatest thickness of dentin. Any undercuts in the dentin for retentive purposes should be in opposite walls of the cavity. The cavo-surface angle may be trimmed with a chisel or a round bur or a cone bur. The remaining decay over the axial wall, if any, should be removed and the cavity is prepared for filling. (Figs. 177 and 178.)

Fig. 177.

Fig. 178.

Buccal cavities in bicuspids are treated in like manners but those in molars are modified by the difficulty of access and the impossibility of applying the rubber dam when the gingival wall is far below the gum. The decay may be removed in the same way and the final forming of the cavity done with a bur in the right angle. There is one frequently occurring buccal cavity which nearly always fails when filled. It occurs

in the distal third of the buccal surfaces of third molars. These surfaces are rarely cleaned by either food or the tooth brush. Sooner or later they involve the whole disto-buccal surface and the occlusal. While they are small cavities in the buccal surface they are so sensitive and difficult of access that proper extension cannot be made, hence recurrence of caries is inevitable. As soon as the occlusal surface is involved a good dovetail can be cut and the filling when inserted sloped off in such a manner as to prevent heavy occlusion upon it.

Lingual cavities in the gingival third are rare. They only occur because of a marked recession of the gums or from wearing an artificial denture. The preparation of the cavity is similar to that in the labial and buccal surfaces. Any variation will depend upon the extent and location of the caries.

2. *The preparation of cavities in proximal surfaces of incisors and cuspids which do not involve the incisal angle.*

General Considerations.—Patients who have neglected their teeth for years take an anxious interest in them as soon as cavities appear in their incisors and cuspids. They recognize at once that if these teeth become unsightly they have lost one mark of beauty. They often allow molars and bicuspids to decay beyond any hope of being restored to usefulness under the foolish notion that they can retain the anterior teeth even if the others are lost. There is no more fallacious notion than this met with in the practice of dentistry, except perhaps mistaking the first permanent molar for a deciduous tooth. It is difficult to decide what is best to do for a patient of say twenty-eight years of age who has lost the power of mastication on his molars and bicuspids and has several proximal cavities in the incisors. The incisors are used for a purpose for which they were never intended, and as a consequence wear down rapidly, cutting off the incisal retention to proximal fillings. While it is true that a patient is justified in becoming anxious when his anterior teeth begin to decay he should in fact be more anxious when his molars and bicuspids show signs of being lost, because the anterior teeth cannot be preserved permanently if they are used for the mastication of food. Artificial dentures of molars and bicuspids alone are but a poor substitute for the natural teeth of mastication. The incisors will be used in preference, to their destruction. It is the dentist's duty when he sees small proximal cavities in the anterior teeth to look into the future sufficiently to educate his patient along the lines of being exceedingly anxious about the condition of the molars and bicuspids. Fillings in the anterior teeth even if small are doomed if they are called upon to bear the stress of mastication. These teeth are thin and small and give but a poor opportunity for the firm anchorage of fillings and if called upon to do a duty they were not intended for there is certain

to be failure. This is the cause of a large class of failures in fillings in the anterior teeth which cannot be classed among failures from recurrence of caries.

It has been found by those of largest experience in filling teeth that there are certain areas of the teeth more susceptible to caries than others. These susceptible areas are found to be those which are not habitually cleaned by excursions of food in mastication, or by the friction of the cheeks, lips, or tongue. Proximal surfaces of the anterior teeth which are close together are not habitually clean, and decay in proportion to their uncleanness. It has also been observed that not all points of proximal surfaces are equally susceptible. All that portion from the incisal edge to the contact point is usually immune and in fact the actual contact point is rarely the seat of beginning caries but a point immediately gingival to the contact is the susceptible area. This is as it were an eddy behind the contact where secretions may rest and plaques form without disturbance. Each case presents its own little variations and should be considered before any operating is proceeded with, because in these days of esthetics the whole susceptible area may sometimes be removed and restored with gold without exposing the filling.

It has been noticed for a long time that proximal gold fillings fail at the gingival margin, which is true, but closer observation has shown that failure rarely occurs in the center of the proximal surface but at the linguo-gingival angle and the labio-gingival angle. That portion of the gingival margin in the center is usually covered with gum tissue and hence does not decay, while both to the lingual and to the labial of this point the free margin of the gum crosses the margin of the filling and at these points recurrence happens. If the margin is placed immediately gingival to the contact it is in a susceptible area and failure is imminent. Teeth which are spaced in the occlusal or incisal third will have their proximal surfaces cleaned by the excursions of food down to the contact and if the margin of the filling is incisal to the contact recurrence is unlikely.

The lingual margin is often a location of failure of proximal gold fillings in the anterior teeth. Operators have too frequently left the lingual enamel plate for the convenience of packing the gold. Cavities are often cut quite over on the labial surface for convenience of access. Such preparations are a mark of the man who is compelled to do too many fillings a day to make a competence. There is often a marked concavity both inciso-gingivally and mesio-distally on the lingual surface of an incisor which leaves the lingual wall little more than enamel if a proximal cavity occurs. If such a lingual plate of enamel is left it is not strong enough to bear the stress of packing gold against it without fracture. Even if this enamel plate does not actually break out during the insertion of the gold

it becomes checked sufficiently to allow leakage. There is only one safe rule to follow. Cut the enamel away on the lingual, until what remains is supported by dentin.

The preparation of small proximal cavities in the anterior teeth naturally divides itself into two general classes. Those which are prepared with a view to the permanency of the filling and those which are prepared knowing that the filling will be more or less temporary. If all the work of the dentist could be made mechanically correct and its permanency was not dependent upon conditions outside of his control, dentistry would be practised as a trade and would not have the power to retain so many bright minds within its ranks. The varying circumstances that influence the permanency of dental operations make dentistry interesting. The only man who can say that his operations will be permanent is the one who does not know or the one who intentionally wishes to deceive. The claim of absolute permanency of dental operations has done much to discredit the profession because the patient who has lost several so-called permanent fillings must think that the dentist was ignorant or dishonest, either of which is not creditable to the profession. Therefore when we speak of preparations for so-called permanent fillings we mean only relatively permanent.

Porcelain fillings have within the past few years taken such a hold on the profession that few gold fillings are now inserted in exposed surfaces of the anterior teeth for patients who value their personal appearance. Though this may be true there is still a large field left for gold and other fillings.

The preparation of cavities for those fillings which may be looked upon as more or less permanent demands a study of the general condition of the patient, the oral secretions, the mucous membranes and the teeth. There must be a careful study of the susceptible and immune areas of the teeth. These considerations will usually demand the extending of the gingival wall of proximal cavities under the free margin of the gum and the labial and lingual walls to those areas which are immune to caries, while the incisal margin will be carried far enough to the incisal to prevent it from coming in contact with the adjoining tooth. If a cavity is so extended there will be no portion of its margin in susceptible areas. The gingival margin will be covered by healthy gum tissue, the labial margin will always be kept clean by foods, the lips, and the brush, the lingual margin by food and the tongue, and the incisal margin by food. The only other requisites for a fairly permanent filling will be perfect mechanical adaptation to the cavity walls and not so much stress of occlusion as will wear, stretch, or dislodge the filling.

The preparation of cavities in proximal surfaces of incisors which must of necessity be looked upon as temporary demand less general considera-

tion but more consideration of the particular reasons for such temporary operations. There must be a perfect understanding between patient and operator when operations are to be made which are not ideal. The ideal operation may be pointed out to the patient and the reasons given for deviations from it. In this way the patient understands what is to be expected from such operations and is not deceived. And besides if the operator shows himself to be a good prognosticator his standing is enhanced in the patient's mind and not diminished if the operation lasts no longer than he said.

While we must admit that all cavities cannot be prepared according to an ideal formula there is no intention in this chapter to countenance slip-shod operating. Every reason that may be given here for not preparing cavities according to the outline in a previous paragraph can be made an excuse for careless operating. One operator may be so much more skillful and deft about his work, that what would be too painful for another operator's patient to bear would be easily borne by his. The rough, unskillful operator will rarely find patients who can bear to have proper preparations made in teeth with living pulps, while the skillful operator will rarely find cases where perfect preparations cannot be made.

If the proper preparation of a cavity would prove too painful for a young patient a temporary operation is indicated, and in such a case where cement is to be used, it is not desirable to break down any more of the enamel than will ensure sufficient access to remove the decay. Then again if small proximal cavities develop slowly and the exposure of gold would be objectionable it would be manifestly better to gain sufficient space to insert small gold fillings than make the ideal extensions. Such small fillings are not likely to prevent further decay for more than three or four years but the patient has not had gold fillings exposed in the teeth for that much of her life. While it is sometimes desirable to make cavities that do not have their margins in immune areas there are certain cases which are so markedly susceptible to caries that they must have their margins carried full well on to immune areas.

Technique.—Separation is a necessity for the proper preparation and filling of proximal cavities in the incisors and cuspids. Space should be gained in such a way as to prevent the teeth from being sore when worked upon. There is no necessity for having the peridental membrane so sensitive that the patient experiences pain from every touch of the tooth. If slight soreness should occur it is well to support the teeth while operating.

Usually the first step in the preparation of proximal cavities in incisors is to chip away the thin enamel with a chisel or a hatchet or hoe excavator. These latter instruments are narrow in the blade and unless carefully used

the points may drop into the sensitive portions of the cavity. The thin edges of the cavity may be shaved down from the incisal to the gingival on the labial and the lingual with the corner of a triangular chisel, holding the second finger on the tooth as a guard. The blade of the chisel should be carried toward the center of the tooth as the edge is carried toward the gingival. A sharp spoon will remove the major portion of the decay. At this time a decision can be made as to the extent of the carious tissue and the probable outline form.

The outline form having been decided upon, the chisel with a keen edge will do more than any other instrument. The enamel may be cut away chip by chip until the incisal margin reaches a point which will be kept clean by excursions of food. Both the labial and the lingual walls may be cut back with the chisel, using the pen grasp, but occasionally the thumb and palm grasp will reach the lingual walls to best advantage. In opening up the cavity the loose decay was removed, also the thin enamel edges, so now the chief concern is with the proper formation of the cavity for the reception of the filling and the prevention of future decay without regard to existing caries. Cavities of less than 1.5 mm. in diameter without much undermining of the enamel can be extended to advantage with a round bur. The largest round bur which will enter the cavity is not so likely to cut into the dentin and cause pain. The blades may be carried against the enamel cutting from the dentin outwards. It will be found necessary to extend the gingival wall considerably rootwards in many cases to insure the margin of the cavity being covered with healthy gum tissue. In the case of the small cavity just mentioned a round bur directed against this wall in the manner described will work quite efficiently. But in the majority of cases an inverted cone bur ½ mm. in diameter for laterals and small cavities, and 1 mm. in diameter for centrals directed against the gingival wall and swept across from labial to lingual and from lingual to labial holding the hand-piece at such an angle as will give the corner of the bur a grip of the tissue will usually cut the dentin gingivally and at the same time make a flat seat for the filling with convenience angles for starting the gold both at the linguo-gingivo-axial angle and the labio-gingivo-axial angle. As the bur cuts into the angles the hand-piece should be swayed in an opposite direction and the bur carried upward along the labio-axial line angle and linguo-axial line angle, thus making a slight groove which should under no circumstances extend more than one-third or one-quarter of the distance to the incisal retention. In this connection it must not be understood that grooves are recommended in either the labial or lingual walls. A slight extension incisally from the convenience angles for holding the filling more securely during its insertion is all that is desirable. As the gingival wall is thus formed the enamel

edge will not be cut away which can be done with a narrow chisel introduced from the labial. Such a chisel should have a fine neck so it may be held at any angle. A round bur may be used to trim the enamel at the gingival but must be held firmly, allowing it to rotate in the proper direction, or it may catch on the edge and pull the rubber off or cut a deep notch in the margin. The outline at the junction of the lingual wall with the gingival and the labial with the gingival must be cut with great care otherwise too much bevel will occur, or these points will not be extended far enough to ensure a clearing margin. It must be kept in mind that these are vulnerable points in these fillings.

Any decay or decalcified tissue that might be remaining in the cavity should be removed. Spoon excavators with thin cutting blades and of a size to readily enter the cavity will rapidly remove the remaining defective tissue. Darby-Perry No. 9, 10, 2 and 4 are thin bladed spoons suitable for small cavities.

Give the cavity proper form to resist any stress that may come upon the filling, also make it of such a form that it will be convenient to fill. In cases where the gingival wall does not need extension for prevention, and the outline form has been obtained and the decay removed, the resistance form, the retentive form and the convenience form may be all made at the same time. An inverted cone bur ½ mm. in diameter for small cavities and ¾ or 1 mm. in diameter for larger cavities in centrals and cuspids will cut a flat seat in the gingival by holding the instrument parallel with the long axis of the tooth and carrying it well into the linguo-gingivo-axial angle and into the labio-gingivo-axial angle as before mentioned. In these cavities it is impossible to cut the gingival wall at right angles to the long axis of the tooth with an inverted cone bur because the shaft cannot be held exactly parallel with the long axis, but if the dentin be cut slightly deeper at the gingivo-axial line angle the outer border or enamel wall may then be trimmed sloping inward except at the cavo-surface angle which should be beveled. The main feature of the gingival wall is to be flat from labial to lingual and form a right angle or an acute angle with the axial wall. There should be no deep grooving of the gingival wall nor cutting of deep pits. A flat seat with walls forming right angles from it is the best form to resist stress. The necessary retentive form in these cavities is provided for in the cut into the linguo-gingivo-axial angle and the labio-gingivo-axial angle and a slight cut into the dentin at the junction of the lingual wall with the labial at the incisal extremity of the cavity. At these points the dentin is the thickest and the cuts are directed away from the pulp. The incisal retention can be completed with an acute angled hatchet, S. S. W., No. 27. This instrument may start to cut at the labio-axial line angle about a millimeter from the incisal

retention and be carried toward the incisal and then started again in a similar position on the lingual carrying each cut around the incisal retention started with the bur. This action of the instrument will deepen the cavity rapidly. It is not necessary to make a deep undercut at this point, it is more important to have a good bulk of gold even at right angles to the axial wall than a fine hole bored deeply. The lingual wall should not under any circumstances be grooved in its length nor should the labial. There are cases where a short groove may be extended from the convenience angles but even these are not necessary in small cavities.

A source of weakness in fillings at the incisal margin is the thinness of the gold. The enamel rods on distal surfaces have a decided incline towards the incisal, and if beveled at all makes the gold thin. This difficulty may be overcome if the incisal retention is some distance gingival to the cavo-surface angle by making a slight concavity from the incisal retention to the cavo-surface angle with a round bur. This deepening

FIG. 179.

FIG. 180.

FIG. 181.

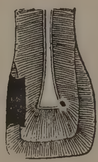


FIG. 182.

between the labial and lingual cavo-surface angles will thicken the gold to the very edge. Such a concavity cannot be cut deep or the retention might be destroyed and the enamel plates under mined. (Figs. 179, 180, 181, 182.)

The enamel wall may be trimmed and beveled with the chisel, round bur or strip, and where there is abundance of space the disk. The disk and strip are very treacherous instruments but in the hands of those who are willing to study their peculiarities are the most tractable at our command. A strip narrower than the inciso-gingival diameter of the cavity held tight and carried back and forth without pressure against the walls will finish an enamel wall in these cavities as no other instrument can. A disk in large cavities may be satisfactory but it should not be permitted to reach the junction of the gingival wall with the labial or lingual or too much bevel will be the result. A round bur is better adapted for these positions.

If the cuttings are now removed from the cavity and the tissue over the pulp carefully inspected the filling may be inserted.

Lower incisors and cuspid cavities demand special treatment in so far as these teeth differ in form from the uppers. They have smaller and longer crowns than the uppers. They are much narrower mesio-distally

and the contact points are always at the incisal edges. The latter fact together with concave proximal surfaces at the gum line make operations prone to failure. The teeth are so thin that the labial and lingual plates of enamel have but little dentin between them, and if retention be cut deeply between these plates for the incisal retention the corner is almost certain to fracture. In some of these teeth the pulp extends far into the crown and is a source of difficulty. Cavities which do not extend close to the incisal edge are simple in preparation and the fillings of fair permanency. There is little or no stress on small fillings in the lower anterior teeth. Retentive form is made as in the upper. In fact the preparation is the same except that there is not as much space between the teeth, and all the instruments should be smaller. Retentive form and convenience angles may be cut with a ½ mm. inverted cone bur holding the shaft at right angles to the long axis of the tooth. The base of the bur may be carried down the lingual wall and sunk into the gingival at the linguo-gingivo-axial angle. The labio-gingivo-axial angle may be cut in like manner using a bur in the right angle hand-piece. The incisal retention may be cut as in the uppers.

3. *Preparation of proximal cavities in incisors and cuspids which involve the incisal angle.*

General Considerations.—Proximal cavities in incisors and cuspids which have become so extensive as to involve the incisal angle have usually been filled before. The conditions which caused the failure of the former filling will be of value in determining what form of preparation is desirable for the new cavity. In such cases as have not been filled before there is often difficulty in deciding whether the incisal angle should be cut away or not. Corners of enamel often stand the force brought upon them before the filling is inserted and break off shortly afterwards. There may be two reasons for this, a tooth with a cavity in it is usually saved a little in mastication but as soon as made comfortable by a filling it receives full force upon it. Or the corner of enamel may be checked during the insertion of the gold and come away later. It is a safe practice to remove a corner of enamel when it has not a support of dentin if the cavity is to be filled with gold. As patients become older the enamel is more and more worn away and seems to check and split more readily than thicker tissue. This is especially true where proximal fillings have failed from wearing away of the tooth tissue leaving the filling to carry too much stress. The margins of cavities in such teeth demand free cutting away of tissue and careful operating to prevent checking of the edges.

The character of the articulation, the peculiar motion of the teeth on each other in mastication and the force of the occlusion all influence the operator in deciding the form of preparation. In most of these extensive

operations failure does not occur from primary decay about the margins, but is secondary to the shifting of the filling or checks in the enamel. If a patient should have no molars and bicuspids suitable for mastication large fillings in the incisors need to be much more firmly seated than if there were good posterior teeth for mastication. Teeth which come together with a kind of anterio-posterior motion, sliding the lowers from the labio-incisal angle of the uppers to the gingival will drive almost any filling from the upper teeth. And if the lower teeth happen to require fillings, they will be as likely to fail as the uppers.

Outline Form.—The determination of the outline form in proximal cavities which involve the incisal angle is not one of extension for prevention in the ordinary acceptation of the practice. It is extension to more securely anchor the filling rather than to prevent decay. The proximal surfaces are usually so far extended before such an operation is contemplated that no further extension is necessary to prevent recurrence of caries on these surfaces. The outline form depends on the age of the patient, the extent of the caries, the thickness of the tooth, the amount of wear on the incisal edge, the friability of the enamel and the character of the occlusion. Depending upon these conditions there are five methods of preparation open to the operator. The first to consider is a modification of the method used in preparing proximal cavities which do not involve the incisal angle. The indications for this form of preparation are thin teeth, young patients, not very heavy occlusion, not much of the incisal edge involved and not much undermining of the corner.

Resistance Form.—The seat and labial and lingual walls are prepared as already described, except that the seat is made broader and longer and the grooves are made deeper. The filling will be called upon to bear heavier stress than those described in the former section and requires a greater seat. The labial and lingual margins should be a straight line from the incisal to the point where they curve to form the gingival wall.

Retentive Form.—Much care is necessary to avoid cutting out all the dentin between the labial and the lingual enamel plates in cutting the incisal retention. To be of the most value this retention must be as near the point of stress as possible and large enough to contain a sufficient bulk of gold to have strength to resist the forces of dislodgment. The horn of the pulp is not always secure from an accident in cutting this retention. It is generally sufficient to make the occlusal wall of this retention at right angles to the long axis of the tooth, but to be certain of doing this it is well to aim to make the depth of the retention closer to the incisal than that at the axial wall.

Technique.—With a wide chisel cut away the corner, shaving both the labial and lingual to the gingival. Some patients' only fear is the

slipping of the instrument and wounding the gum or touching the sensitive portions of the cavity. In such cases a coarse disk or a thin stone will trim away the enamel corner readily and with less anxiety to the patient. Remove the softened dentin and form the seat with an inverted cone bur 1 mm. in diameter which may be held parallel with the long axis of the tooth and carried into the labio- and linguo-gingivo-axial angles, cutting deeply into the dentin at these points and carrying a groove towards the incisal less than half way. The incisal retention may be cut with an inverted cone bur held at right angles to the axial wall giving the corner of the bur a catch into the dentin some distance gingivally to the final occlusal wall. Slight grooves may now be cut toward the gingival from the incisal retention. A disk only is the instrument to finish the enamel walls. It can be held to cut the enamel parallel with the length of the rods and then to slightly bevel the outer third. The incisal cavo-surface angle will bear considerable bevel. Remove any remaining decay from the axial wall and clean up the cavity walls. (See Figs. 183 and 184.)

Fig. 183.

The second method is suitable in thin teeth, young patients, incisal surface not much worn nor not much involved, corner undermined. Chiefly useful in laterals. Pits and grooves in the lingual surface may be included in such a preparation.

The outline form is the same as in the last case except that there is a tongue or dovetail cut in the lingual surface at least one and a half mm. from the incisal edge depending upon the form of this surface. The margins of the dovetail should join with the lingual wall in rounded corners.

Fig. 184.

The resistance form at the gingival is the same as in the last case.

The retentive form in the incisal region is entirely different. Instead of cutting between the labial and lingual plates as in the former case the incisal retention is cut into the lingual surface in the form of a dovetail. The dovetail is cut about one and a half mm. in depth, depending upon the thickness of the tooth and the nearness of the pulp. The direction depends upon whether there are defects in the enamel of the lingual surface or not. It is generally advisable to make this retention at right angles to the proximal wall and about one and a half mm. inciso-gingivally and about one and a half to two mm. mesio-distally. To be of the greatest value as retention it must be cut as near as possible to the incisal but must not be so near as to weaken the edge.

Technique.—The technique up to cutting the supplementary retention in the lingual has already been described. It is always difficult

to control the hand-piece to cut into the lingual surface of any tooth and it is especially difficult to do so in this case, if it becomes necessary to use the right angle. Where this form of preparation is advisable the lingual surface is usually markedly concave inciso-gingivally thus making it almost impossible to reach it with the straight hand-piece. Unless the operator has confidence in his ability to hold the hand-piece and operate through the mouth mirror it is better to raise the chair, tip the patient's head back and operate by direct view. A No. ½ or ¾ mm. inverted cone bur should be held at right angles to the lingual surface of the tooth, starting the corner of the bur on the lingual wall of the cavity at the junction of the enamel with the dentin. This bur will cut a slot the full depth of the enamel and the necessary distance towards the opposite side of the tooth. The enamel edges should be cut back and, if need be, the slot cut larger and made retentive in form,

FIG. 185.

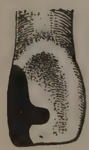


FIG. 186.

FIG. 187.

that is, the incisal and gingival walls must be slightly undercut. (Figs. 185, 186 and 187.)

The third method of preparation is indicated in thin teeth, corner undermined, edge much involved, lingual plate of enamel badly decayed, and heavy occlusion and appearance of gold not a serious objection. In such cases there is a step cut in the incisal surface, its width depending upon the extent of the destruction of the cutting edge. As a rule the step should extend mesio-distally farther than the width of the filling to be supported. The depth depends upon the weight of occlusion and the thickness of the tooth.

Technique.—When it has been decided to cut across the incisal exposing the gold on the labial surface a stone is the most suitable instrument to begin with. Cut the incisal edge down the width and depth required. Prepare the proximal cavity as in case two. With an inverted cone bur cut a groove from the proximal cavity across the step between the labial and lingual enamel plates, deepening and enlarging the groove at its extremity. A good deal of care is necessary in cutting this groove to keep it from coming too close to the labial plate and at the same time have it large enough to contain sufficient gold to have strength.

The fourth method is more frequently applicable than either of the last two described. This method of preparation was first described

by Dr. Johnson and takes his name. It is indicated in thick teeth, much worn, corner undermined, edge much involved, heavy occlusion, brittle enamel, old patients, lingual surface not too much involved. The successful preparation of such a cavity and filling it with gold demands much consideration before it is undertaken and careful manipulation afterwards.

Technique.—The seat and proximal surface are prepared as in the last two cases. Dependence for the retention of the filling is in the step cut across the incisal. The step does not involve the labial plate and yet the incisal surface is completely covered with gold. The step is largely at the expense of the lingual surface. The labial wall must in consequence be cut with a definite angle with the axial wall. The labial wall in the step must also meet the pulpal wall with a definite angle to give the necessary resistance to a heavy occlusion coming against the lingual surface of so large a filling.

Fig. 188.

Fig. 189.

Fig. 190.

The outline from a labial view is shown in Figure 188. There is no exposure of gold except as a proximal filling. If the incisal surface has been sufficiently worn to expose the dentin the outline will show the whole occlusal surface faced with gold. (Fig. 189.) The lingual outline will show almost a third of the surface covered with gold. (Fig. 190.) Those surfaces of the tooth which are exposed to heavy occlusion are covered with gold and those surfaces which are exposed to view from without show but little gold.

An inverted cone bur held against the axial wall at right angles to the long axis of the tooth will, if carried across the incisal, cut the step about 1 mm. in depth. This first cut must be kept well to the lingual or the labial plate may be so thin as to expose the gold through the enamel. The lingual plate may now be trimmed away with the chisel. Usually it is necessary to carry the inverted cone bur across the incisal again to make the step flat and at right angles to the stress. The extremity should be deepened to give additional strength and to resist tipping. The groove through the dentin forming the step should not be more than ½ mm. deeper than the lingual wall except as it approaches the extremity where it may be slightly deeper, while at the same time the lingual wall is not trimmed away so much at this point. There may in some cases be some difficulty in obtaining sufficient resistance to forces which may happen

to be applied to the labial surface. But as a rule fillings are rarely tipped to the lingual.

Finishing the enamel walls demands a careful study of the direction of the enamel rods at every point. The labial wall of the step may be beveled with a fissure bur, a disk or a round bur. This wall is sloped from the junction of the labio-incisal angle to the pulpal wall of the step. The extremity of the step is best trimmed with a round bur. The lingual wall of the step must have a slight bevel and join with the proximal lingual wall in a rounded form. A sharp corner at this junction would invite failure either during the insertion of the filling or afterwards by the occlusion. At the junction of the labial wall of the step with the proximal wall is a source of weakness if a sharp angle is left to the enamel. A small disk in the right angle will reach the lingual cavo-surface angle and also the labial.

The fifth method is applicable in those cases where there is an edge to edge bite, wearing the teeth down to expose the dentin and perhaps loosen-

FIG. 191.

FIG. 192.

FIG. 193.

FIG. 194.

ing the incisal retention in a small proximal filling. There is not much of the incisal edge lost and yet a proximal filling cannot be retained because of the rapid wearing of the tooth and the difficulty of cutting an incisal retention. The surest method to follow is to cut the step clear across the incisal including all the exposed dentin and beveling both the labial and lingual enamel walls toward the pulpal wall of the step. Of course, enough of these walls must be cut down to face the whole end of the tooth with gold. The preparation of the proximal cavity should be done as before described except that it does not require any provision for retention because the step will provide all the resistance necessary. There is little or no force to drive the filling to the labial or the lingual because there is little loss of these surfaces. The chief point of difficulty in preparation is at the junction of the proximal cavity with the step. There must be bulk enough of gold at this point to ensure against stretching. If a sharp corner is left at this junction it tends to leave a point to start the stretching of the gold. The technique of preparing this cavity is so much like those just described that it is not necessary to repeat it. (Figs. 191, 192 and 193.)

Shoeing.—There is a class of cavities met with in old patients so similar to the one described in the previous paragraph that it might not be out of place to describe their preparation here. They are strictly speaking occlusal cavities but they are not similar in origin to other occlusal cavities already described. As patients advance in years their teeth become worn until the dentin is reached which soon hollows out in a cup shape on the occlusal surface. This exposed dentin often becomes quite sensitive to acids and in fact is dissolved or worn away so rapidly that the pulp is often involved. The teeth become much shortened and unsightly. To foresee and prevent such unhappy results is the duty of the dentist. If a tooth seems to be cupped out even though there is little direct antagonism of the opposing tooth, it is well to prepare a cavity for the reception of a gold filling which will cover the exposed dentin and prevent its further wear. The anterior teeth, both upper and lower, are chiefly subjected to such wearing because so many people have lost their molars and bicuspids.

Fig. 195.

Technique.—The technique of preparation is simple. This eburnated dentin is not usually sensitive to cut. An inverted cone bur can be held parallel with the long axis of the tooth and carried across the occlusal surface cutting a groove about a millimeter in depth. As the tooth is worn down a good deal it is quite thick labio-lingually giving ample room for good anchorage. The extremities of the groove should not come too close to the mesial or distal surfaces. The inverted cone will make all the undercuts necessary to keep the filling from being lifted from the cavity which is the only force that can dislodge it. The walls should be sloped into the cavity and the finished filling should come over the entire end of the tooth and be of sufficient thickness to resist stretching or curling up at the edges from constant hammering of the opposing teeth. (Figs. 194 and 195.)

PULPLESS INCISORS HAVING LARGE PROXIMAL CAVITIES

While the majority of incisors which have lost their pulps and have large proximal cavities require to be filled with porcelain or should be cut off and restored by a crown there are cases which should be filled with gold.

The difficulty in preparing such cavities is to avoid cutting away the dentin; because so much has been already lost by getting access to remove the pulp there is no strength left to retain and support a filling. In thin teeth not much worn on the incisal, a fair amount of dentin, and not much filling exposed to occlusion the chief retention may be obtained in the pulp chamber. The pulp chamber should be filled with cement and then the gingival wall cut wide and flat as if the pulp had receded markedly. Grooves may be cut in the labial and lingual walls part of the distance to

the incisal, depending upon the thickness of the tooth. The incisal retention should be cut with an inverted cone bur placing it into the pulp chamber and cutting towards the incisal, thus getting a good undercut without going near the incisal. The aim should be to make up in bulk of gold (the greater portion of which will be in the pulp chamber) for not getting the retention as near the point of stress as in other cases.

If the tooth is thin and the decay together with the cutting to remove the pulp has involved a good deal of dentin any further cutting of dentin is contra-indicated. It is better to depend for retention of the filling upon a post cemented in the root canal and extending far enough into the cavity proper to give a good attachment for the filling. There is no further preparation of the cavity required than to give it proper outline form and resistance form; the post will provide the retention. The technique of inserting a post in an incisor so that a gold filling may be condensed around it is not always easy. Select a piece of iridio-platinum wire No. 16 for a central or cuspid and No. 18 for a lateral. Ream out the canal about five to seven mm. in depth, not the same diameter the full depth, as it is usually better to taper the wire slightly. To do this it is best held in a pin vise for filing. With heavy pliers give it the necessary bend to enter the canal and project in the center of the cavity so that gold may be packed between it and the cavity walls and also cover it at the surface. To accomplish this it will be necessary to fit the pin in the cavity, mark it about the proper length and remove it to cut it off. Then file it down to some extent and perhaps flatten that portion extending into the cavity with a hammer on the anvil so as to conform with the flat shape of the tooth labio-lingually. Before setting in cement it should be tried in and note taken of its length, its size and proper position to allow gold to be packed around it, and its capability of retaining the filling. (Figs. 196 and 197.)

FIG. 196.

FIG. 197.

4. *Preparation of cavities in bicuspids and molars which do not involve the occlusal surface.*

While the general rule is laid down that all proximal cavities in bicuspids and molars should be extended through to the occlusal surface there are cases in which it is better practice not to do so. In the very old, the very young and in cases of immunity to caries it is not always wise to extend proximal cavities to the occlusal surface, but such operations must be looked upon as temporary in character.

There is more or less recession of the gums around the necks of the teeth as age advances. The gum tissue which once filled the inter-proximal space does not more than half fill it at fifty or sixty years of age. Thes open spaces between the teeth serve as pockets for the collection of foo

which ferments and acts as a starting point of decay. The cementum is exposed and decays rapidly. In such cavities which are usually shallow and girdle the tooth it would be manifestly unwise to extend through to the occlusal surface. There is plenty of access, the contact is far occlusal to the cavity and the tooth is thick enough occluso-gingivally to bear any stress which might come upon it. Besides old patients should be treated with a good deal of consideration. Radical and painful operations should be reserved for those in the vigor of life. Old people dread dental operations even more than the child who has been told of the horrors of the dental chair.

For many reasons, as has already been said, it may not be wise to make a full extension of cavities occurring in the proximal surfaces of the teeth of the very young. These patients are often so nervous and restless in the dental chair that anything like ideal operating cannot be undertaken. It is better in such cases to do temporary work rather than create a dread of dental operations in the minds of young patients. Again the warning must be sounded that oversensitiveness, etc., must not be made an excuse for improper extensions. While we must all admit that such cases are met in practice yet there are not nearly so many of them as some of the old operators would have us believe.

Often a large proximal cavity is found in the mesial surface of a first permanent molar and after it has been opened up and prepared for filling the beginning of a cavity is found in the distal surface of the second bicuspid. Now comes the problem. What should be done with such a defect? If it is left without a filling it is certain to decay. If a small filling is inserted whose margins are in contact with the adjoining filling recurrence is almost certain within a very few years. Should the whole proximal surface together with the necessary step be cut out now, or should an attempt be made to get a clearing margin to a filling confined to the proximal surface? The answer to these questions depends upon the conditions present. If the patient be a young girl and caries progressive and a full extension would seem impossible a small cavity may be prepared. It must be explained to the patient that this is a temporary operation which will need careful examination every few months. Any change of color about the filling will be a signal for its removal. By this method perhaps two or three years have been gained and the patient at this time will be glad to have a more permanent operation made. If the patient be robust and the dentin not too sensitive and a tendency to caries and lack of care of teeth, the cavity should be prepared in the most ideal manner. Then there is the middle course which may be followed if there is a marked immunity to caries. The cavity may be extended as much as possible to clear the margins but yet confining it to the proximal surface. There

are many cases of thick necked teeth where this preparation will have fairly good cleansing margins. The management of this type of case in practice will indicate what may be done with similar cavities in other locations.

Many times small cavities are found in the proximal surfaces of teeth in patients of middle life which have not increased in size for years, or perhaps at one time decay was rapid but for some cause or another has ceased. The walls of these cavities will be dark or even black in color, the enamel about them does not seem to have its normal histological structure when cut, the dentin in the bottom of the cavity does not seem to be sensitive. In some of these cases there may be a slowly progressing caries at only one location in the cavity. Radical extensions of cavity margins are not indicated in such cases. It is not necessary to cut such cavities through to the occlusal surface if there is abundance of access and there is sufficient thickness of tissue left to bear the forces of occlusion.

Technique.—The technique of preparing proximal cavities in bicuspids and molars which do not involve the occlusal surface is quite simple. They are simple cavities and are prepared as buccal, labial, or lingual cavities. There is no force to dislodge the filling.

5. *Preparation of cavities in the proximal surfaces of bicuspids and molars which involve the occlusal surface.*

The preparation of cavities in the proximal surfaces of molars and bicuspids opens up the "question of extension for prevention" again. While there may be excuses for not extending proximal cavities in the anterior teeth there cannot be the same excuses for not doing so in the bicuspids and molars. These teeth are wider bucco-lingually than the anterior teeth, the proximal surfaces are often flat which in a measure accounts for more frequent failures in these teeth than in the anterior teeth. The bicuspids and molars are usually closer together and rarely as well cared for as the incisors.

The outline form depends upon the age, and sex of the patient, the character of the carious process, the strength of the closure of the jaws and the friability of the enamel. The extent of the caries is a factor in deciding the location of the outline only when it has gone beyond the susceptible areas. All small cavities of decay are extended until immune areas are reached. The gingival wall is cut away until the margin of the filling will be covered by healthy gum tissue. The buccal and lingual walls are extended until the margins are quite clear of the adjoining teeth and may be kept clean by the action of the lips, the tongue, the tooth brush and food in passing over them. The outline of such cavities on the occlusal surface depends to some extent upon the depth and direction of the fissures. While cutting proximal cavities through to the occlusal gives more

perfect access to the proximal cavity it also gives an opportunity for cutting out defective grooves or fissures in the occlusal surface and forming a step for the filling which is the chief source of retention. The outline in the occlusal should be formed so as to give the greatest amount of retention for the filling with the least cutting away of tissue. The buccal and lingual walls should be parallel and at right angles to the seat of the cavity. There should be no acute angles or irregularities in the outline.

Technique.—In the ordinary proximal cavities where the occluso-proximal marginal ridge has not been broken away and but slight defects in the occlusal fossa the simplest method of procedure is to cut into the fissure in the occlusal with an enamel drill or fissure bur about ½ mm. in diameter. This instrument should be carried right through the marginal ridge leaving a slot, the edges of which can be broken down with a chisel. If the cavity be a distal one, Black's side instruments work admirably. At this juncture the decay in the proximal cavity may be removed with spoon excavators and the cavity washed out with a stream of tepid water. If the rubber is now applied and the cavity dried the full degree of extension may be decided upon. In the great majority of cases where the proximal decay has been at all extensive the buccal and lingual walls may be cut back with the chisel. If the enamel is supported by dentin it will be impossible to cut it back with the chisel until the dentin is first removed. This may be done with an inverted cone bur which is placed in the seat of the cavity and carried from the center to the buccal and then carried towards the occlusal undermining the enamel. This may be repeated on the lingual wall and if the gingival needs extension it may be cut with the same instrument. The chisel will now shave back the enamel slightly beyond the point of the removal of the dentin. A narrow necked chisel may be passed between the teeth to shave the gingival enamel away. In many of these cases it is difficult to control an inverted cone bur along the seat and keep it from jumping out of the cavity or dropping dangerously near the pulp. If an Ivory matrix is adjusted the bur may be held tightly against it while it is cutting and thus prevented from doing what was not intended. The outline of the step should be completed by carrying an inverted cone bur 1 mm. in diameter as far to the opposite side of the tooth as the fissures extend and at this point carried to the buccal and lingual enough to make the cavity at the extremity a little more than ½ mm. wider bucco-lingually than any other point in the step. Instead of widening the extremity of the step as just described it may be deepened about half a millimeter and slightly undercutting buccally and lingually. This method is applicable where there are no fissures or angular grooves requiring removal. There is always some difficulty in properly trimming the enamel at the junction of the occlusal outline with the proximal. A

careful study of the behavior of the enamel as it is cut away is the only guide to the proper beveling.

The resistance form of cavities in bicuspids and molars is of first importance because these teeth and their fillings are called upon to bear heavy pressure and sudden impacts from hard substances in the closure of the jaws. The chief dependence to resist this heavy stress must be in a flat seat and step which are at right angles to the force applied. There should be no dependence put in grooves or undercuts in the walls of the cavity to resist the stress of occlusion.

As the outline form is being gained the resistance form is being provided for. The inverted cone bur which was swept across the gingival wall made the seat flat form buccal to lingual and from the cavo-surface angle to the axial wall. And as the step was being cut out with the same form of instrument it was made flat. The junction of the axial wall with the step should be slightly rounded just so as not to leave a sharp corner which might be the starting point of stretching the gold under the heavy biting in some mouths. If decay has removed a good deal of the axial wall thus lessening the area of the step it may be restored with cement and formed as if it were dentin.

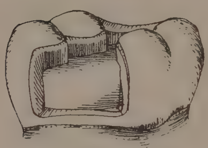
The retentive form is largely provided for in the resistance form and the outline form. However, there are forces which may dislodge fillings in bicuspids and molars though they would resist the heaviest of stress. Such fillings must be so placed as to prevent their being tipped from the cavity or lifted directly out. The tipping stress is overcome by the dovetail in the occlusal surface and by providing sufficient bulk of gold in the step so that portion of the filling in the proximal surface may not be broken away from the step. As the buccal and lingual walls are being cut back the inverted cone bur is allowed to cut deeply into the bucco-gingivo-axial angle and carried occlusally about two-thirds the distance to the step, thus making the slightest grooves, which widens the cavity bucco-lingually at the seat and not at the step. It must not be understood that the outline is wider bucco-lingually at the seat than at the step. It is only in the depth of the cavity that it is wider. A slight undercut in the step will provide against the lifting of the filling if the walls cannot be widened as just mentioned or if the proximal cavity is to be filled with non-cohesive gold or tin-and-gold, and finished with cohesive gold.

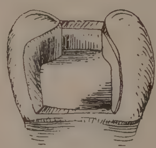
The convenience form has already been provided for in the angles cut at the seat and in opening up the cavity to the occlusal to gain free access. There is no more fatal mistake in the formation of this cavity than allowing the proximal walls to diverge as they approach the gingival. Even if such cavities are successfully filled the least condensation of the filling after it is inserted will result in the gold drawing away from the margins.

The enamel walls should be first cut in the length of the rods and then the cavo-surface angle beveled the required amount at every point. If the operator notices the manner of cleavage of the enamel while trimming the walls he will be guided in their final polishing and beveling. Any mistake in the proper bevel of the enamel is sure to be followed by fractures of the enamel around the filling.

Technique.—A disk will trim, bevel and polish part of the buccal and lingual walls on the proximal and part on the occlusal. A disk will not reach the margins near the gingival without cutting too much bevel nor will it reach the walls at the extremity of the step. These locations must be trimmed with a bur. A chisel will trim the gingival wall. Darby-Perry gingival enamel chisels will sometimes do good service at these points. (Figs. 198, 199, 200, 201, 202 and 203.)

If any decalcified tissue remains over the axial or pulpal wall it may now be carefully cut away and the cavity cleared of any chips.





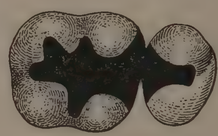


FIG. 198. FIG. 199. FIG. 200. FIG. 201. FIG. 202. FIG. 203.

The procedure of preparing these cavities is slightly modified if the proximal decay is extensive enough to undermine the enamel both buccally and lingually. In such cases the walls are readily cut away with the chisel and the seat is easily formed. What is of considerable moment in these cases is the support of the buccal and lingual cusps and at the same time to get enough resistance form for the filling. Caries has reduced the area of the step and the area of the seat cannot be increased by cutting into the tooth until the axial wall is at right angles with the seat and step, without involving the pulp. The next best thing to having a step of dentin is to have one of cement. The cement serves the purpose of a non-conducting lining and a support for the metal filling.

Lower bicuspid cavities deserve special mention inasmuch as they are of different form from the uppers. Proximal decay in lower first bicuspids which have low lingual cusps must be prepared as the anterior teeth. The groove between the cusps is rarely defective in the low cusped variety. In the high cusped variety there are usually two pits on the occlusal separated by a ridge of perfect enamel which need not be cut through to form the step if the occlusion is not heavy. These teeth are often wide enough bucco-lingually to permit of the whole cavity being

dovetailed. The lower second bicuspids demand more resistance form, and even though there is a good transverse ridge it should be cut across to get enough resistance and retentive form to retain a large proximal filling.

In special large mesio-occlusal cavities in upper molars there is often some difficulty in managing the mesio-buccal cusp which has become undermined. The cusp is usually high and not well supported by dentin. If a fissure should run over the buccal from the central fossa then there is no doubt about what should be done. Cut the whole cusp down with a stone as far distally as the central groove. It should be cut low enough to leave room to be covered with sufficient bulk of filling material to bear the stress of mastication. And if it be cut further rootwards as it approaches the central groove giving it a general slant to that portion of the cavity it will help to resist the tipping stress on the filling. The same method of managing the disto-lingual cusp will often add to the retention of the filling and remove a weak cusp which is likely to be fractured. Mesial cavities in lower molars occasionally involve one of the cusps and need the same treatment. (Fig. 204.)

FIG. 204.

There is a class of cavities in molars which is often puzzling to the beginner. They occur as the result of defective enamel over the whole occlusal surface. Caries often ceases after the whole enamel surface is stripped off. There are spots of penetration but for which they might not need operative interference. The pulps are alive and apparently normal in the patient under fifteen years of age. It is mostly considered wise not to devitalize such pulps if they can be retained alive. Grind off any projecting spiculæ of enamel. Remove the decayed tissue with spoons and if hard remove with large round burs. The only force which is liable to dislodge a filling from such a tooth will be a lifting one. To overcome this and to keep the filling from being forced off the end of the tooth cut a continuous groove with an inverted cone bur all the way around the tooth about midway between the enamel and the probable location of the pulp. A groove made with such a bur will have undercut enough to resist the lifting stress. If a groove cannot be cut all the way round, good sized pits may be cut at the four corners. These will give sufficient hold for a filling if it is not built too high. (Fig. 205.)

FIG. 205.

THE MANAGEMENT OF LARGE PROXIMO-OCCLUSAL CAVITIES IN PULPLESS BICUSPIDS

Bicuspids are so narrow mesio-distally and the pulp cavity is so situated in the crown that when the necessary cutting is done to remove the

pulp from a proximo-occlusal cavity there is little dentin left to support the cusps. It usually happens that if a bicuspid has decayed deeply enough in one surface to involve the pulp the opposite surface is also defective. This increases the weakness of the cusps. With the present knowledge of inlays it is hardly ever advisable to fill such bicuspids with gold foil. The malleting of so large a filling is sufficient to endanger the walls by wedging the gold between them. Very occasionally a post might be inserted in the root canal of a bicuspid to act as a support to a gold filling. Such a post is more serviceable in lower bicuspids where the transverse ridge is not often defective and the post serves for retention without cutting a step across the occlusal.

THE MANAGEMENT OF LARGE CAVITIES IN PULPLESS MOLARS

The secret of success in filling large cavities in molars is to cut away the enamel freely. Leave as little enamel exposed to occlusion as possible. Grind it low enough to be well covered with filling material. Enamel exposed to occlusion in a pulpless molar must be supported by a large bulk of dentin or failure is certain. Posts screwed into the root canals often assist in supporting a large proximo-occlusal filling which would otherwise have to be supported by cutting deeply into the dentin of the tooth, thus unnecessarily weakening the whole structure. Large cavities in the lower molars rarely need a post for the retention of the filling. The pulp chamber may be used for this purpose by cutting a groove around its walls at the base. The bulk of filling in the chamber will be strong enough to resist any tipping stress and the undercut will resist the lifting force.

THE TECHNIQUE OF INSERTING A SCREW POST

The technique of inserting a screw post into a root canal for the purpose of supporting a filling or a tube for a jacket crown is simple and yet has to be done a few times to gain speed and get the best results. The screw posts which are the most suitable have square heads with a tapering thread as a screw nail. The thread is sharp and will cut into the dentin as it is forced into the canal. Select the proper size of post, ream the canal slightly smaller than the post. Screw the post in and out a couple of times. Mark the point on the post when screwed into place at which it should be cut off to be properly covered with filling material. Remove the post, nick it deep enough with a file so as it will twist off when fully twisted down to place after being dipped into soft cement or chlora percha. A post to be of service should not extend through the filling nor yet be so short that the filling cannot be thoroughly packed around it. If the post is intended to resist a lifting force that portion of it which is in the filling should be riveted to form a head on it. There is always some danger of splitting a root by screwing a post in too tightly.

CHAPTER XI

THE TREATMENT OF SENSITIVE DENTIN

BY J. P. BUCKLEY, PH. G., D. D. S., F. A. C. D.

GENERAL CONSIDERATIONS

It is claimed by the best authorities that "*in the normal condition dentin should be without sensation;* and that the source of sensitive dentin, or of impressionable pulps, lies in their continued subjection to irritation by which responsiveness is developed" (Barrett). This view is, I believe, generally conceded to be correct by all who have given this subject their attention. It is true that in the preparation of cavities for fillings we find few teeth the dentin of which is without sensation. This fact is not surprising, nor can it be construed as being contrary to the statement that normal dentin is not sensitive, when we remember that there are few teeth in the mouths of patients demanding the services of the dentist, the dentinal fibrillæ and pulps of which have not been subjected to continued irritation.

In the discussion of means and methods by which the sensitiveness of the dentin can be allayed I shall not attempt to enter into the details of many histologic and pathologic phenomena which are certain to arise in the consideration of the *therapeutics* of this subject; but shall confine myself largely to the drug aspect.

It is desirable at the outset that the reader should understand and appreciate the fact that there is no other one source of failure in operative dentistry so great as the improper preparation of the cavity. This result does not always follow because of ignorance on the part of the operator of the principles involved in cavity preparation, but often times because the patient will not permit, or the operator does not feel justified in inflicting, the pain necessary in carrying out those principles.

The sensitiveness of the dentin can be obtunded in no small degree by the use of various therapeutic agents; and I might state that there are few operations which we are called upon to perform wherein the patient will appreciate our efforts more than in this by applying drugs and remedies for the mitigation of pain. But in order to apply intelligently and successfully any remedy, whether it be a drug or an

agent, to the dentin and thereby obtund the sensitivity of the dentinal fibrillæ without endangering the vitality of the pulp itself, we must be familiar with several factors or conditions, which I cannot with propriety here discuss, in detail at least. For instance, a thorough knowledge of the anatomic and histologic structure of the tooth is of the highest importance, as is also a knowledge of the pathology, not only of the fibrillæ, but of the pulp tissue as well—the changes which these structures are capable of undergoing if unduly irritated by the application of the remedy employed. Still another factor of equal importance, and one which more directly relates to the phase of the subject under consideration, is a knowledge of the pharmacologic action and the therapeutic application of the drugs and remedies used for this purpose.

The tendency in dentistry as well as in medicine today is towards rational therapeutics. Empirical methods of treatment are being rapidly relegated to the past. Before using a drug or an agent for allaying the sensitiveness of dentin, or for any other purpose, we should know what *action* to anticipate from its employment. This is not too much to expect from the trained dental practitioner of today.

THERAPEUTICS

The remedies suggested for obtunding sensitive dentin have been many and varied. I shall discuss only those which, from clinical experience, have proved of sufficient value to merit consideration; and for convenience of study, will divide them into four general classes.

I. *Physical Agents.*—Any agent, whether heat, cold, light, electricity, or any influence whatever, if employed in the treatment of a diseased condition, is a *remedy*. There are some physical agents by the proper use of which the sensitiveness of dentin can, in a measure, be obtunded.

(1) *Heat.*—The application of dry heat to a sensitive cavity, especially in conjunction with a dehydrating agent such as absolute alcohol, is always an aid; and this is accomplished by means of heating dry air, and gently directing a current of air thus heated into the cavity which has been isolated by the rubber dam and moistened with the dehydrating agent used. Care must be taken not to primarily cause pain, otherwise the object of using the agent would be defeated.

Several apparatuses have been devised for heating the air. The late Dr. Rudolph Beck, of Chicago, perfected a convenient electrical device by means of which compressed air can be heated as it passes through. Other such devices are on the market. The modern switchboard has a heated air syringe as a part of the equipment. In the absence of any of these the chip-blower can be employed; however, with less satisfaction.

Inasmuch as heat is used in conjunction with another and more important class of remedies, I shall refer to this agent later.

(2) *Cold.*—A lesser degree of heat, commonly designated *cold*, is another physical agent sometimes employed for the purpose of desensitizing the dentin. Heat may be abstracted from the tooth structure by spraying the cavity with a highly volatile liquid, like ether, rhigolene, or ethyl chlorid. In the use of these agents, advantage is taken of the physical law that *a solid in changing its form to a liquid, or a liquid in changing its form to a vapor or gas, must abstract from the thing to which it is applied, a certain amount of heat in order to effect the change.* Ether, or combinations containing ether, and ethyl chlorid, both used as sprays, have proved valuable in some instances, especially shallow cavities near the gum the dentin of which is difficult to obtund by the usual methods employed, and to which reference will be made later on in this chapter.

A precaution to be taken to prevent primary pain in applying this remedy, is to fill the cavity temporarily with stopping, and direct the spray first on this and surrounding parts, after which the stopping can be removed and the spray directed into cavity without any appreciable pain. The degree of refrigeration must not be carried to the point of having a possible deleterious effect subsequently upon the pulp or gum tissue.

(3) *Light.*—A form of energy called *light* has also been brought forth as having a peculiarly favorable effect upon hypersensitive patients. In one method the rays of light are colored by passing through a blue glass. This is accomplished by darkening the room and employing a blue bulb (16 or 32 c.p.) on an ordinary electric socket. Whether the light acts locally, or affects the vision and thus the general nervous system, has yet to be demonstrated. The result of the author's experience with this agent has not been encouraging. It is true that light differs in effect from heat, though both come from the same heated body. This phenomenon is observed in the action of light on certain chemicals; for example, the silver salts, some of which are used as obtundents, undergo a chemical change when exposed to sunlight or luminously hot bodies.

(4) *Electric Current.*—This agent has been employed as a means of carrying certain drugs into the dentin and pulp tissue for obtundent purposes. The method is called *cataphoresis;* but because of the expensive and complicated apparatus, the length of time required to obtund as well as oftentimes unsatisfactory, and, in not a few instances, disastrous results, the method has generally been discarded.

II. *Escharotics or Caustics.*—Escharotics, or caustics, are agents that destroy or disorganize the tissue upon which they act. Any drug or agent, then, which will cauterize the dentinal fibrillæ, will obtund

sensitive dentin. There are many drugs, however, belonging to this class that cannot be used for this purpose because of their deleterious effect upon both the tooth structure and the pulp tissue. For instance, the strong mineral acids will disorganize the protoplasmic dentinal fibrillæ; but they will also disintegrate the inorganic structure of the tooth. Arsenic trioxid has a specific poisonous action upon the fibrillæ, but there is no known means of preventing the same deleterious effect upon the cells of the pulp tissue.

The most valuable escharotics for desensitizing the dentin are:

Phenol, Trichloracetic acid,
Zinc chlorid, Silver nitrate.
Trioxymethlen.

It must be noted that, while these agents will obtund, the ultimate result is too often produced, with the possible exception of phenol, at the expense of quite as much suffering as they save.

Phenol has local analgesic properties beside that of cauterant, and will, therefore, be discussed under another and more important class of agents.

Zinc chlorid in various strength solutions can be used to advantage in a class of cavities where the decay or softened dentin does not extend too close to the pulp. Zinc chlorid coagulates albumin and in the process hydrochloric acid is liberated. For this reason the application of strong solutions is painful and should not be employed in deep cavities unless the irritating action of the agent is modified. This can be done to a marked degree by selecting alcohol and chloroform as the vehicle in which to make the solution.

A useful formula is here given:

℞—Zinci chloridi,	gr. xx
Alcoholis,	f.ʒ iv
Chloroformi, q. s. ad.	f.℥ j —M.

Sig.—Apply to the cavity on a small pledget of cotton and gently evaporate to dryness.

Note: If the zinc salt does not make a clear solution in the alcohol it indicates that some of the salt has been oxidized; the solution can be cleared by adding one drop of hydrochloric acid.

This remedy is a disinfectant and it has the added advantage of sterilizing the dentin at the same time that it produces its obtundent effect.

Trichloracetic acid in concentrated solution causes considerable pain when first applied to a sensitive cavity, therefore defeating the object of its use; but in a 10 or 15 per cent solution it produces but little pain or inflammatory reaction. In this strength it can be employed; but not always with satisfactory results.

Silver nitrate is perhaps the only known prophylactic for decay. In the posterior part of the mouth where the cementum is exposed to external influences and thus sensitive, or in shallow cavities, especially in children's teeth, the use of this drug, in the solid pencil form or in various strength solutions, will be found valuable, both as a means of reducing the sensitiveness and preventing further ingress of caries. As an agent for obtunding the sensitivity of the dentin in an ordinary cavity, it should not be considered for various reasons. When the agent is employed for the purposes above mentioned, the cavity, after the application, should be kept free from saliva for a few minutes, and, if possible, exposed to sunlight, thus decomposing the silver salt as referred to in this chapter under the subject of *light*. In the absence of sunlight, a practical means of decomposing the salt is by the use of the electric mouth lamp. A solution of sodium chlorid should always be at hand when using silver nitrate, and in case any of the latter agent should accidentally get on the mucous membrane of the patient's mouth its action can be checked at once by rinsing the mouth with this antidotal solution.

Trioxymethylen, called also paraformaldehyd, has recently come into quite general use as a desensitizing agent and will be mentioned later in connection with the author's **Desensitizing Paste.**

III. *Local Anodynes or Local Anesthetics.—A local anodyne* is an agent which, when applied to a part, relieves *pain*. A *local anesthetic* is an agent which, when applied, produces insensibility to *pain* in that particular locality. According to Long, it rather produces a condition of *analgesia*, which means the absence of sensibility to pain, as distinguished from *true anesthesia*, the absence of all sensibility.

In the judicious use of agents belonging to this class the author firmly believes will ultimately be found the surest and safest road to success. The following agents, or a combination of two or more, will be found to be of the utmost importance:

Cocain,	Eugenol,
Procain (novocain),	Phenol,
Neothesin,	Ethyl chlorid,
Menthol,	Ether,
Oil of cloves,	Chloroform.

Cocain is one of several alkaloids, this being by far the most important, obtained from the leaves of Erythroxylon Coca, a plant indigenous to Peru and other South American states. Both the alkaloid, cocain, and the alkaloidal salt, cocain hydrochlorid, are used in various ways for obtunding sensitive dentin, as are also the synthetic substitutes for cocain, more recently developed, such as procain (novocain) and others. The alkaloidal salt was formerly recognized by the United States Pharmacopeia as cocain hydrochlorate; but in the later editions (1900–1910) it is called

cocain hydrochlorid. An important physiologic property of cocain to be remembered here, is its power, when applied directly to the mucous membrane or when injected or forced into the pulp tissue, of inducing a condition of analgesia in the part by paralyzing the sensory nerve filaments. In addition to this it causes a blanching of the part which is subsequently followed by congestion. It should also be remembered that pharmacologists have proved, beyond a doubt, that cocain is a *general protoplasmic poison;* that muscles as well as nerves and nerve-ends cease to contract or to conduct stimuli when they are exposed to even dilute solutions of the drug. The only reason that the deleterious effect is more noticeable upon nerve than upon other kinds of tissue is that here we are dealing with the medium of sensation and expression.

The author deems it wise to call attention to these well-established physiologic, pharmacologic and pathologic facts, for many instruments have formerly been devised for forcing various strength solutions of cocain hydrochlorid, not only into the dentinal tubuli, thereby paralyzing the fibrillæ, but into the pulp proper, anesthetizing this organ as well. In view of these facts it would appear that we are seldom, if ever, *justified in completely anesthetizing the pulp of a tooth for the purpose of painlessly preparing a cavity therein.* Therefore under the subject of *cataphoresis* in this chapter, little was written; and for the same reasons, the method of anesthetizing the pulp by *high pressure* or conductive *anesthesia*, for obtundent purposes only, will not be considered. Both of these methods will be discussed in a subsequent chapter on pulp removal.

Cocain and the alkaloidal salt, cocain hydrochlorid, are safe and valuable agents for obtunding sensitive dentin, if confined to the dentinal structure of the tooth. Frequently in deep-seated cavities, especially in children's teeth, the sensitiveness can be completely overcome by sealing in the cavity for a day or two a creamy paste made by mixing the alkaloid cocain with liquid petroleum. The revised edition of the United States Pharmacopeia now recognizes an *oleate of cocain* (5 per cent), which can be used for this purpose. The paste or oleate should cover the entire surface of dentin which we subsequently expect to excavate. Good results can also be immediately obtained by the use of the following remedy:

℞—Cocainæ,	gr. xx
Chloroformi,	f. ʒ ij
Etheris, q. s. ad,	f. ℥ j—M.

Sig.—After the rubber dam has been adjusted, apply to the cavity on a small pledget of cotton and evaporate to dryness.

In the use of this remedy, advantage is taken of the physical law previously referred to in this chapter under *cold*. As the volatile liquids, ether and chloroform, evaporate, a certain amount of heat is abstracted

from the tooth structure, and a coating of the alkaloid, driven to an extent into the dentin, is left in the cavity. This remedy will not completely obtund all sensitive dentin, but its use will be a material aid.

There can be no objection in favorable cases, provided the dentin has been previously sterilized, to using aqueous solutions of cocain hydrochlorid with uniform pressure over the entire area of the cavity, thus forcing the anesthetizing solution an equal distance into the dentin. This is an extremely difficult thing to do without forcing the solution at some more favorable point in the cavity through the tubuli and into the pulp. However, there are cavities where good results can be accomplished by the careful use of this method. In some cases of gingival cavities good results can be obtained by hypodermically injecting a 1 or 1.5 per cent solution of cocain hydrochlorid or a 2 per cent solution of procain into the pericemental membrane somewhere near the apex of the root. This practice should not be generally recommended.

Procain, formerly known under the trade name of *novocain*, may be substituted for cocain and used as above described. Its action is much slower; and, for the purposes here mentioned, it possesses no advantages. Sterile, isotonic solutions of procain are recommended to be used hypodermically for *hypersensitive dentin.* The drug is injected by the infiltration, interosseous and conductive anesthesia methods. (See works on local anesthesia—several of which are now published.)

Neothesin.—The use of this agent in combination with other drugs for desensitizing dentin will be discussed later.

Menthol, a stearopten obtained from the essential oil of peppermint, can be substituted for the cocain in the above prescription with ether and and chloroform, and used in exactly the same manner. An oily liquid (mentho-chloral) can be formed by heating together over a water-bath or rubbing in a mortar, an equal amount of menthol and chloral. This remedy will be found efficacious by sealing in the cavity for a few days.

Oil of Cloves.—A profound analgesic effect can be produced upon sensitive dentin, especially in deep-seated cavities, by using oil of cloves and heat in the following manner: After carefully desiccating the dentin by means of warm alcohol and gentle heat, a pledget of cotton saturated with oil of cloves should be placed in the cavity and a current of heated dry air directed thereon until the cotton is nearly dry. This should be repeated as often as the case demands.

Eugenol, an oily product, is the chief constituent of oil of cloves and can be used in the same manner as above described.

Phenol.—It is gratifying to the author to know that in the last revisions of United States Pharmacopeia (1900–1910), the product heretofore erroneously called carbolic acid has been recognized by its correct name, *phenol.*

This agent can be substituted, with equally good results, for the oil of cloves or eugenol as described in the foregoing method. Care should be taken here, however, in directing the heated air so as not to cause the fumes of phenol to escape on the patient's face. Oil of cloves, eugenol and phenol are three true *local anodynes*, and any one of which, if hermetically sealed in a cavity for a few weeks, will check the continued irritation of the fibrillæ and pulp, thus aiding nature to restore these structures to their normal condition when they should not be responsive. By this means, then, the sensitiveness of the dentin can also be allayed.

Ethyl chlorid, ether and chloroform, by their rapid volatility, produce a condition of analgesia, thereby obtunding sensitive dentin, as previously explained in this chapter under *cold*.

IV. *General Anodynes or Analgesics.—General anodynes or analgesics* are remedies which relieve pain without necessarily inducing unconsciousness or general anesthesia. They may accomplish their object by acting upon the perceptive centers of the brain, the afferent paths in the spinal cord, or the peripheral nerve through which the painful impression is transmitted (Stevens).

In order to do permanent work for certain highly nervous patients, it is sometimes necessary to resort to the administration of this class of drugs. This was especially true before the introduction of Desensitizing Paste and the modern and improved methods of using local anesthetics. The agents largely used for this purpose are:

Opium,	Nitrous oxid,
The bromids,	Chloroform.

Opium is a most powerful analgesic, and while there are some dental conditions where this drug, or its chief alkaloid, morphin, is truly indicated, it ought not, in the author's judgment, to be given for the treatment of sensitive dentin.

The bromids of potassium, sodium and ammonium are valuable drugs in certain cases. Perhaps there is no drug which will quiet a nervous patient more readily, when the nervousness comes purely from fear or dread, than potassium bromid, which is the representative of this class. In such cases, where it is deemed necessary, the following prescription will prove helpful:

℞—Potassii bromidi, ʒ jss
Syrupi sarsaparillæ comp., f. ℥ iij—M.
Sig.—Take a tablespoonful in water after meals the day before coming to the office.

Nitrous Oxid.—There are several apparatuses on the market by which nitrous oxid gas can be administered through the nose. With the newer and improved gas outfits oxygen can be mixed with nitrous oxid in varying

proportions, as the case demands. It is possible with such an apparatus to carry the patient just to the analgesic stage, and hold him there indefinitely until a sensitive cavity has been painlessly prepared. In cases where the operator feels that it is necessary to resort to this method, good results can be accomplished.

Chloroform.—With the patient in the upright position, chloroform can be carried to the analgesic stage and sensitive cavities prepared. Most authorities agree, however, that chloroform should not be administered unless the patient is in the recumbent position, and that the analgesic stage is the most dangerous. Death has been known to occur suddenly, after a few inhalations, in cases of marked idiosyncrasy against the drug. Hewitt, De Ford and others report excellent results from the use of chloroform in the manner above described. In selected cases the author has used the method with uniformly good results; but with the later methods of handling these cases, one is hardly justified in resorting to the use of chloroform for this purpose.

CHAPTER XII

FILLING MATERIALS: THEIR CHARACTERISTICS, INDICATIONS FOR THEIR USE AND THE METHODS OF MANIPULATION

BY ALFRED OWRE, B. A., M. D., C. M., D. M. D.

The dentist of today is, perhaps, more occupied with the treatment of caries, both in theory and in practice, than with any other branch of his profession. Although we recognize, in the prevalent custom of treatment by filling, only a provisional substitute for some more nearly perfect one at which, in our present stage of development, we have not yet arrived, it behooves us, until we shall have outgrown it, to study closely its methods and materials.

In the discussion of materials we are confronted by the fact that in the very nature of things there can be no one substance suited to all cases. There is, however, for every case a suitable material, or one which can be continued in use as such until, in our pursuit of the ideal, we progress to something more effective.

To acquire the art of filling teeth seems at the outset an Alpine task. A thorough understanding of the properties of various necessary materials will reduce difficulties immensely, just as in setting out for a long climb in the mountains the providing of guides and the study of maps will reduce distances and minimize dangers.

It will be the aim of this chapter to point out as clearly as possible the teleological value and characteristic properties of gold, amalgam, tin, cement, and gutta-percha. We shall try to suggest when and where to apply these materials in filling cavities of teeth to insure the highest degree of success; and also to describe the methods of preparation, insertion, and finish.

GOLD

From the earliest days of dental surgery, gold seems to have been considered the filling material *par excellence*. It occupies a unique prominence in operative dentistry. The ancient uses to which it was put for royal and religious ornament rendered its more common properties familiar to the metal-workers of even prehistoric times. The greedy, but persistent, alchemists of mediæval laboratories have contributed to modern science

the results of their research for "the philosopher's stone." Gold has had, therefore, one great advantage—that of familiarity—over the later filling materials whose properties were little known and in whose actions scientists were slow to become interested.

The appeal of gold, to primitive man, inhered in its peculiar combination of luster and yellow color. This color is deepened or raised in tone by the introduction of foreign substances, copper for the former purpose, and silver for the latter. In allotropic form it is susceptible of alteration to other than the original color. When reduced to a finely divided state by precipitation, violet, dark red, purple, brown, and even black may be produced. However, when burnished or fused, it again assumes its characteristic yellow color.

Another peculiar property of gold is its extreme malleability. In this respect it exceeds all other metals. It can be reduced by beating to $\frac{1}{1370000}$ of an inch in thickness. It also heads the list in ductility. A single grain may be drawn out into a wire over five hundred feet in length. Both of these properties are modified or rendered *nil* by alloying.

As to the property of hardness, gold, when pure, lies between silver and aluminum. It is about one-third as hard as diamond. This property is generally increased by the presence of alloys, extremely small quantities of some elements (bismuth, lead, etc.) having a very marked effect, even to rendering the metal capable of pulverization in a mortar.

As regards tenacity, pure gold will hold a weight of seven tons per square inch. This property, also, is reduced by the presence of impurities.

The specific gravity of cast gold is 19.3, which can be increased by condensation. In some of its precipitated forms it may be as high as 20.3. The difference is accounted for by the annealing in the former case.

In general, gold is weldable in the cold state in proportion to its purity; a very minute trace, 1 in 1000, of foreign metal such as silver, copper, or platinum, is said not noticeably to interfere with its cohesiveness. This property is usually increased by heating.

The presence of other metals alloyed with gold renders it more susceptible to the occlusion of obnoxious gases. The cohesive power is decidedly lessened by surface gases such as ammonia, hydrogen, hydrogen phosphide, and sulphurous acid gas, all of which are attracted to pure gold, but to a greater degree when the metal is finely divided than when it is cast.

In the scale of conductivity, with silver first, at 1000 for both heat and electricity, copper is second, and gold third with a register of 548 for heat, and 730 for electricity.

Its solubility is proved in aqua regia and in mixtures producing nascent chlorin, bromin, and, under certain conditions, iodin.

The consideration of the qualities essential to a good filling material is a very important one. According to Dr. G. V. Black, the chief qualities are:

Indestructibility in the fluids of the mouth. Adaptability to cavity walls. Freedom from shrinkage or expansion after having been made into fillings. Resistance to attrition and the force of mastication. Of secondary importance are color, non-conductivity of thermal impressions, and convenience of manipulation. It should also be capable of receiving apolish.

Bearing its constant properties in mind, let us see how gold fulfills these requirements.

There can be no question as to its indestructibility in the fluids of the mouth; although iodin discolors it somewhat, it does not cause solution. It is highly capable of adaptation to cavity walls. There is neither shrinkage nor expansion; but the intermittent forces of mastication may work, together with the peculiar molecular structures, to produce some change in form. The yellow color and high burnish, so beautiful in themselves, are, as fillings, more or less of an objection from the esthetic viewpoint. The contrast in color between the gold and the enamel may be rendered less noticeable by attention to the outline form of the cavity. An outline may be varied for the sake of grace, without hindering the achievement of artistic results, bearing in mind, of course, that the application of gold is not, primarily, assumed to be inartistic. Conductivity is a decidedly unfavorable property. In regard to the manipulation of gold, we may say that, in general, it is difficult, and demands sustained effort. It is generally acknowledged that success with this material exacts close application and prolonged study. As to finish, a perfect surface depends only upon the gold being reasonably well condensed.

As to the use of gold, it is not easy to lay down set laws. When and where to apply it depend upon a close study of general conditions and upon the extent to which the operator's instinct for the eternal fitness of things has been cultivated. No aspect of dentistry demands keener judgment and finer appreciation of practical and esthetic values. Moreover, the physical condition and idiosyncrasies of the patient constitute a large factor in the problem. The age and state of health, both general and local, must be taken into consideration. Mental traits, as well, will be weighed by the tactful dentist, since the immature mind, and that which is under imperfect nervous control, must be met with special resources.

It must be borne in mind that in man as in other animals the period of plasticity is the age of education. Organization and education, physical and mental, have sometimes reached a stage of balance early in life. When this happens, rather extensive gold fillings may be made for patients between the ages of ten and sixteen years.

Between twelve and eighteen, the age of adolescence, the powers of the body develop at a lower rate than those of the mind; and it would be unwise to attempt the insertion of large gold fillings unless the entire system of the patient be adequate to the strain.

As the patient advances in years, the physical and nervous resistance must not cease to be a matter of careful consideration. If this resistance be below par, or if all extra energy be needed to nurse some disorder, it is best to postpone large gold operations.

Locally we have many things to consider, such as conditions of the peridental membrane, the extent and acuteness of decay, the structure and strength of cavity walls, occlusion, wear and tear, the position of the tooth, accessibility, and possibly also the past hygiene and care of the mouth.

It is quite needless to say that no gold filling should ever be attempted in any tooth when there is manifest pericemental inflammation. The slight loosening of the tooth as a result of deposits, or of wear and tear, need not prohibit the insertion of gold; but if any great degree of loosening has taken place, gold is generally contra-indicated. Whether the membrane is abnormal or not, its resistance should be a guide. If caries is rampant, it is often advisable not to consider gold until more favorable conditions, or a period of immunity, ensue.

The firmness of the cavity walls may be insufficient to withstand the force necessary for the proper introduction of gold, especially if the strength of the bite is in the neighborhood of 175 pounds. Many malleted gold fillings fail in strong occlusions. They may also fail where the area of masticating surface has been lessened by extractions of molar teeth. In this latter case, it often occurs that proximo-incisal fillings have been literally pounded out, owing to the excess of work performed by the anterior teeth.

In regard to position, the tooth may be inclined to such a degree as to render gold difficult to insert, and, in consequence, preferably omitted.

The use of gold need not be restricted to any particular teeth, for instance, as has been often suggested, to the ten anterior teeth. It would be more scientific, and decidedly more practical to say that, other things being equal, we can use it wherever there is sufficient accessibility. So far, then, it becomes the ideal.

Much has been said about this material. In fact, it would seem that nothing more remains to be said either for or against it. When we consider that the future preservation of the teeth depends upon the extent to which recurrence of caries can be prevented, and normal conditions and functions otherwise restored, we naturally seek a filling material which will as much as possible further these aims. Statistics have been published showing

that the average life of a gold filling is three years. Just so long as gold is used indiscriminately, and by all kinds of operators, will we have such figures.

But these are not the statistics by which we wish to be influenced. It debases our own standards, and works injustice to the best men in the profession of dentistry—those who are most influential, and who make up a very large proportion of the total number—to obscure their results by fusing with them the results of the incapable, and then striking an average. Such statistics are misleading. It would be much more to the purpose to take account only of those men who are preeminently fitted to practice dentistry. Such men are honest enough to acknowledge failures wherever they occur, and if data were gathered exclusively from them, some reliable figures would exist upon which changes could be based when it is found that the percentage of failures is becoming too high.

Not to go any further with this discussion, we may, for the moment rest upon the statement that success hinges upon careful judgment in the selection of cases, as well as upon manipulation or technique of insertion and finish.

In all discussions of the subject, so much is said as to the importance of purity in gold, that it has been thought best to quote in full the Roberts-Austen refining process as given in Rose's *The Metallurgy of Gold:*

> Gold assay cornets, from the purest gold which can be obtained, are dissolved in nitrohydrochloric acid, the excess of acid expelled, and alcohol and chlorid of potassium added to precipitate traces of platinum. The chlorid of gold is then dissolved in distilled water in the proportion of about half an ounce of the metal to one gallon, and the solution allowed to stand for three weeks. At the end of this time the whole of the precipitated silver chlorid will have subsided to the bottom, and the supernatant liquid is removed by a glass siphon. Crystals of oxalic acid are then added from time to time, and the liquid gently warmed until it becomes colorless, when precipitation is complete, a point reached in three or four days if ten-gallon vessels are used. The spongy and scaly gold so obtained is washed repeatedly with hydrochloric acid, distilled water, ammonia, and distilled water again, until no reaction for silver or chlorin can be obtained, after which it is melted into a clay crucible with bisulphate of potash and borax, and poured into a stone mold. Lack of care in any one of the operations will result in gold containing one or two parts of impurity in ten thousand.

If further purity is desired, the gold may be redissolved and reprecipitated until satisfaction is attained.

Gold comes to us from the manufacturer in two varieties, foils and crystals. A complete description of the manufacture of foil occurs in an article entitled "Gold Beating" in the *Encyclopedia Brittanica.*

The sheets are usually four inches square, and the number by which each one is identified corresponds to the number of grains in the sheet;

e.g., in No. 4 foil each sheet weighs 4 grs., and so on up to No. 100, or higher. Above No. 20, the sheets are rolled out instead of beaten. They may be had smooth or corrugated.

Foils may be classified according as they lack or possess the property of cohesion. They are non-cohesive, semicohesive, or cohesive. Non-cohesive gold is made so by surface treatment, and although the process is not made public, we know that we can render pure gold non-cohesive by exposing it to ammoniacal gas.* The semicohesive golds, and some of the non-cohesive, can be made cohesive by annealing, which demonstrates that surface treatment had consisted, in this instance, of subjection to a volatile gas.

Some non-cohesive foils are permanently so, and the gases covering the surface are probably of the sulphur or phosphor groups, which cannot be volatilized by heat, but condense upon the surface.

Foil has been used for about a century, chiefly in a non-cohesive state. The discovery of its cohesive property, about fifty years ago, marks an era in the history of operative dentistry. It has made contour possible in its broadest sense, and the resulting advances are of tremendous importance. That the possibilities are not yet exhausted is another point which should encourage the profession towards progress.

The crystals of gold are obtained by precipitation. The manufacturers guard their trade secrets so well that we do not know what precipitating agent is used. Oxalic acid, purified sulphurous acid gas, and other chemical reagents can be used, but at present these are largely replaced by electrolytic methods. There are on the market several variations of these forms, of which the fiber-like crystals are generally to be preferred. It is very probable that the crystals have a higher specific gravity, since they have never been subjected to fusion. They are usually sold in the cohesive state. Among qualities decidedly in their favor is a plasticity which renders them easy to manipulate.

There has been, and still is, some prejudice against gold in this form, owing to a variable quality which can be accounted for, in a measure, by the fact that crystals are more easily contaminated.

Although methods of preparation have been more or less faulty in the past, modern methods have given us a fairly reliable product, with the result that crystals have increased in use.

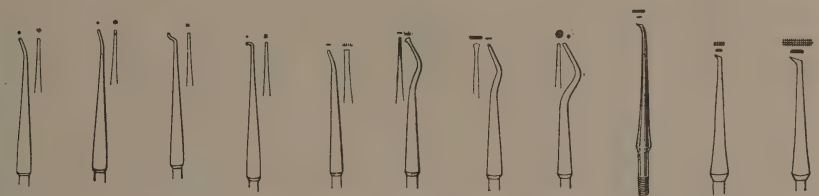
The dentist should procure a gold which is experimentally known for its good qualities; but he must always be on the lookout lest unscrupulous manufacturers permit deterioration.

There is a variety of ways in which the dentist can shape foil as wanted, and to suit the various cavities: the ribbon, mat, cylinder, pellet, or rope. In some of these shapes it can be bought ready prepared.

* Dr. G. V. Black, *Dental Cosmos*, Vol. 17.

The ribbon is formed by taking as much as is required of a sheet of gold and, by repeated folding, reducing it to the desired width. The mat is made by simply folding the width of the ribbon upon itself according to size wanted; cylinders, by rolling the ribbon upon a flat broach. The pellet may represent from $1/32$ of a sheet upwards, rolled to a loose ball between the ends of the fingers. The ropes or rolls are made by rolling a part of the sheet between the thumb and forefinger, or between two napkins. The heavier foils need only to be cut into strips of suitable size.

Dr. Black recommends keeping the gold in a compartment where ammonia is present, thus rendering it non-cohesive, and protecting it from other gases. If desired, cohesiveness may, of course, be restored by annealing. For this purpose, gas, alcohol, or electricity may be used as a means of heat. Gas, alcohol, or any open flames are objectionable on account of contaminations, grain alcohol being the least so. A sheet of



FIGS. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216.

mica or a porcelain tray may be used between the flame and the gold, thus reducing the objection to a minimum. The electric annealer is by far the best.* It distributes the heat evenly and at varying degrees. It also does away with handling the gold during the annealing process.

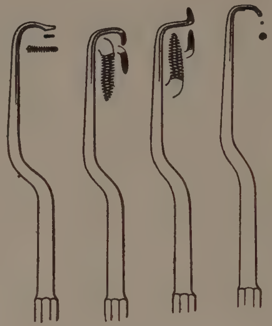
In discussing the insertion of gold, it is assumed that the cavity is prepared according to the principles laid down in the chapter on the preparation of cavities for fillings.

Non-cohesive gold is not used very frequently for the entire cavity, since surrounding walls are necessary to its insertion, and in this day of specialization few men are enabled to acquire skill in its application. There seem to be scarcely enough points in its favor to compensate for the time consumed in acquiring this skill. Its use is limited to simple cavities. As no union of the gold laminæ takes place, the wedge principle of insertion must be depended upon.

The cylinder is the best shape to use for this work. It should be somewhat longer than the depth of the walls against which it is to be forced. Several cylinders are placed endwise in the cavity, and forced against each surrounding wall with a wedge-shaped instrument, thus leaving a space in

* The Custer electric annealer is generally recognized as the superior make.

the center within which are placed other cylinders until it is impossible to make room for any more. The whole mass is then condensed by a suitable plugger point, the outer ends thus being forced as far as possible into the cavity. The cylinders should always be of sufficient length, so that, when tightly wedged and finally condensed, the cavity will be over full.



FIGS. 217. 218. 219. 220.

It is claimed for the non-cohesive filling that when it is used water-tight margins are more perfectly made, and fillings are inserted with greater dispatch, provided the peculiar skill demanded for its manipulation has been acquired.

Filling cavities with cohesive gold, an art which requires years to master, demands less theorizing than demonstration, more actual experience than ponderous texts, so decidedly practical are all its details. Success is based upon many considerations, to some of which reference has already been made. The importance of modern cavity preparation cannot be too strongly emphasized, for upon it much depends. Separation of the teeth for the purpose of accessibility, and fixation to render the attachment tense, are also of moment.

A large variety of plugger points is needed to fill special wants, but for ordinary purposes the dentist confines himself to a few forms with which he has become thoroughly familiar. The illustrations, Figs. 206 to 216, will be referred to as occasion demands.

The shank of each plugger should bend a few degrees so that it will not interfere with the operator's view of the working point. The modern law of accessibility in cavity preparation has limited the modifications in the shank to only three besides the above; namely, the bayonet, the right angle, and, for special work, the complete reverse. (Figs. 217, 218, 219, 220, 221.)

FIG. 221.

All should be finely serrated. It is also well to remember that .5 mm. is about as large condensing area of a point as should ever be used. The force necessary to condense gold with larger areas is generally unbearable, and is also liable to cause bridging over or imperfections in solidity. Small points which pierce the gold should not be used.

Another factor to consider is the manner of obtaining condensing force. Hand pressure is the simplest. The hand mallet, the automatic and other

mechanical inventions, are all applied more or less. Dr. Black recommends the mallet in the hands of an assistant as the best means. It should be a rule always to place the gold where wanted in the cavity, and closely pack its laminæ with a light hand pressure, then mallet until the required solidity is obtained. The force should be so directed as to distribute itself evenly over the tooth-attachment; that is, toward the long axis. This causes the least inconvenience to the patient.

Perfect adaptation to cavity walls and margins, and adequate condensation, are the chief objects of attainment in these fillings. Both are interfered with by over-annealing. In fact, the very first pieces introduced in the cavity may be unannealed cohesive gold, which secures more easily, and with more certainty, the above-mentioned adaptation. Masses of

FIG. 222. FIG. 223. FIG. 224. FIG. 225. FIG. 226.

FIG. 222.—Axio-mesio-distal Plane. Showing gold started.
FIG. 223.—Axio-mesio-distal Plane. Showing floor covered and advance of axial walls.
FIG. 224.—Axio-mesio-distal Plane. Overfull and ready for finishing.
FIG. 225.—Longitudinal Section, Bucco-lingual Plane, Mesial Fourth, through Retention Form of Cavity. Showing gold started. Dotted lines represent the outline form of the cavity.
FIG. 226.—Same as Fig. 225. Showing the union complete, and surface brought up.

gold, if too large, cannot be properly placed and condensed. For starting the filling, 1/32 of a sheet No. 4 foil is quite sufficient, or an amount that may be readily anchored into one angle of the cavity. It is generally not advisable to use a mass of gold the bulk of which is more than one-third the size of the cavity.

A solid plug is obtained only by carefully welding each newly added mass to that already in the cavity. In doing this, the force exerted in manipulation must not in any way distort the filling or interfere with adaptation, but rather be so directed as further to insure adaptation and stability. The plugger should, therefore, generally proceed from the center to the periphery. It is never judicious to exert force on thin layers of gold covering flat surfaces. Moreover, in covering margins, especial care should be taken to have a good cushion of gold over the margins, thus avoiding danger of the plugger point coming in contact with the tooth tissue.

In filling a simple cavity, the process of building the gold is illustrated in Figs. 222, 223, 224. Plugger points 206, 207, 210 and 215 are used in this class of cavities in the anterior teeth, and as we go back into the mouth the bayonet, 213, will also be needed.

The filling of a complex cavity is best illustrated in the mesio-occlusal of a first upper molar. (Figs. 225 to 230.) The axio-bucco- and axio-linguo-gingival point angles are first filled, and then the axio-gingival line angle is covered, starting from each point angle respectively, so that the surface represents an angle of 45 degrees with the axial or gingival wall, and the latter is built out upon until its margin is fully covered. The

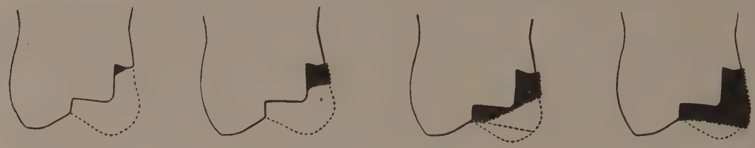


FIG. 227. FIG. 228. FIG. 229. FIG. 230.

FIG. 227.—Longitudinal Section, Mesio-distal Plane, Buccal Fourth. Showing gold started (as in Fig. 220).

FIG. 228.—Showing the progression of the gold building after gingival wall has been Covered

FIG. 229.—Same Section and Plane, but Cut through Middle of Tooth. Showing locking of step, and proximal part of filling.

FIG. 230.—Same as Preceding. Gold building complete.

filling should then proceed swiftly to the contact point, and, in doing so, one should as nearly as possible preserve a flat surface; but the inclination from buccal to lingual may vary according to accessibility. For this part of the work pluggers 206, 207, 211 and 212 are used for starting the filling, and 213, 214, 215 and 216 for further condensing. The step portion of the cavity is started in the same manner as the simple cavity, but instead

FIG. 231. FIG. 232. FIG. 233. FIG. 234. FIG. 235.

FIG. 231.—Mesio-distal Plane. Showing the starting of gold.

FIG. 232.—Same as Fig. 226. Showing progress of gold building and union of incisal part with the rest of the filling.

FIG. 233.—Same Section. Gold building finished.

FIG. 234.—Axio-mesio-distal Plane. Showing process of gold building in cavities involving angle.

FIG. 235.—Same Section as 229. Gold building finished.

of building up over the missing wall, the operator laps the gold over the proximal portion, and builds the whole out until it is overfull.

The practice of making mesio-occlusal-distal fillings in one operation should be discouraged. It is economy in every respect to make two proximo-occlusal fillings instead; however, they may be so interlocked as to represent the same outline form as the mesio-occluso-distal filling.

The proximal cavities of the anterior teeth present some difficulties owing to the fact that we have less surrounding wall. (Figs. 231 to 233.)

For illustrative purposes take the mesial of a central incisor. The gingival point angles are filled first, and the axio-gingival line angle is covered as described in the preceding case. The surface of gold should then be built toward the incisal, preserving an angle of about 45 degrees, and it should be borne in mind constantly that the lingual portion is to be kept in advance. The incisal retention form is filled as soon as the gold can be attached from it to the main portion, and the body of gold thus tied and strengthened.

Great care should be taken in covering the margin both lingually and labially at the proper time, and also in sufficiently contouring the lingual. In cavities involving the angle without a step, the building of the gold is continued to proper contour. (See Figs. 234 and 235.) Pluggers used for the gingival retention form are 206, 207, and 208; for the body of the

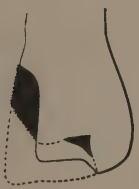


FIG. 236.


FIG. 237.


FIG. 238.

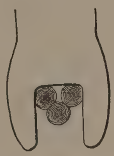


FIG. 239.


FIG. 240.

FIG. 236.—Mesio-distal Plane. Showing disto-pulpal angle filled.
FIG. 237.—Same as Preceding, further Progress.
FIG. 238.—Same as Fig. 232. Gold building completed.
FIG. 239.—Upper Second Bicuspid. Axio-bucco-lingual plane. Showing the three non-cohesive cylinders of gold in place.
FIG. 240.—The Same Tooth as that in Fig. 234. Axio-mesio-distal plane, showing partially condensed mass of non-cohesive gold projecting over gingival cavo-surface angle.

filling, 214, 215, and 216; for the incisal retention at times necessary to add, 209.

When the incisal edge is involved, and the step preparation has been made, the filling of the proximal portion is proceeded with precisely as described until the step is reached. The retention form in the incisal part is then filled from the disto-pulpal angle, and the gold built down so that its surface will present an angle of 45 degrees with the pulpal wall, and on towards the proximal portion, covering the incisal edge. Lastly, the union of the two portions is completed, and carried out to contour. The force exerted here should always be so as to drive the whole filling more tightly into its retention and resistance forms. (Figs. 236 to 238.)

In the filling of a mesio-inciso-distal cavity in the six anterior teeth, the proximal portions are filled as before; in filling the incisal portion, however, the center should proceed faster than the angles, and it is also best to build one angle out to contour first, remove the separator, and proceed with the remaining one exactly as before.

A great deal has been said about the percentage of failures of adaptation to the gingival wall in bicuspids and molars when using cohesive gold for the entire cavity, although on this point statistical figures may vary quite as widely as do opinions of what legitimately may constitute such figures. Some of the best operators prefer to use a certain amount of non-cohesive gold in the gingival part of the cavity. The advantage is, besides better adaptation, a saving of time which is, of course, a vastly important factor in the economics of the question.

The non-cohesive gold should not fill the whole of the retention form.

FIG. 241.—Labial View of Six anterior Teeth. Showing contour and contact.

The usual method of procedure is to place one cylinder in the axio-lingo-gingival point angle, another in the axio-bucco-gingival, with a third between, and partially force them together with the pluggers 211 and 212. The cylinders used should be about twice as long as the gingival wall is wide mesio-distally to allow for after-condensation. (See Figs. 239 and 240.) The cohesive gold is now forced into the non-cohesive, using an assistant plugger, while locking the gold from the lingual to the buccal wall. Thus the cohesive gold really forms the fourth surrounding wall

FIG. 242.

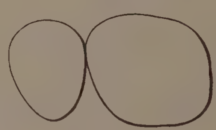


FIG. 243.

FIG. 242.—Buccal View of Bicuspids and Molars. Showing contour and contact.
FIG. 243.—Occlusal View of Upper Bicuspid and Molar. Showing contour and contact.

for the non-cohesive. Thence the filling is proceeded with as in the operation already described where cohesive gold was used for the entire cavity.

The final condensation of the non-cohesive gold takes place from the surface, by means of large parallelogram pluggers (see Figs. 216, 217, 218, and 219, the last three for distal surfaces).

In finishing, it is assumed that the cavity has been overfilled to allow for trimming away of enough gold to leave a perfectly smooth surface, and still have proper contour. The instruments and appliances for this purpose are many. Of them, the following are indispensable: A plentiful supply of corundum stones in various sizes and grits, sandpaper discs and

strips, the Wilson saw frame (Fig. 245) and saws cut down to a thread-like thinness, Dr. G. V. Black's trimming knives (Figs. 246, 247, 248) and Dr. E. K. Wedelstaedt's gold files. (See illustration, Fig. 249.)

Generally the first cutting is done with the aid of corundum stones or sandpaper discs and strips, depending upon locality, and, in proximal positions, the saw is an adjunct of great importance. Thereafter, the steel instruments, chisels and excavator for inaccessible places in occlusal fillings, trimming knives and files, and, for the final smoothing, cuttle-fish discs, pumice stone, whiting, or rouge, used with suitable appliances.

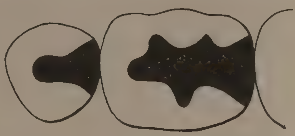


FIG. 244.—Occlusal View of Lower Bicuspid and Molar. Showing contour and contact.

The chief watchword in this part of the work should be: Lacerate the tissues as little as possible; reproduce natural form plus the *needed* contour and contact point (Figs. 241 to 244); obtain as smooth a surface as possible so that an explorer will pass from filling to tooth tissue without catching. Always cut from the gold to the tooth tissue as far as possible. As to the use of the knives, only thin shavings should be cut, and the force should be directed so as not to disturb the filling.

FIG. 245.

Occlusal fillings are first ground down with corundum stones and water, starting with reasonably coarse grits, and finishing with finer ones. A variety of shapes is necessary in order to reach well into grooves and variations in surfaces. A good polish can be obtained by using fine, wet pumice stone powder applied with wooden wheels or points, rubber discs, or moosehide wheels. This may be followed with whiting and even rouge for a very high degree of polish.

In buccal, labial, and lingual fillings, the use of discs should be substituted for part of the corundum work; but both these materials are very liable to cut too much into the filling. The pointed fissure burs can be used over the gingival margin. The Black trimming knives and Wedelstaedt files are all of use here. The polishing is done as above indicated.

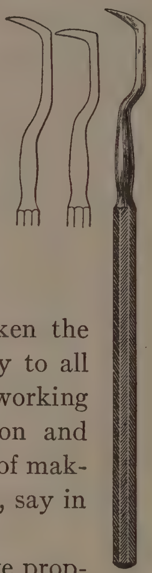
In the proximo-occlusal fillings the saw is passed under the gingival overhang, and should be first drawn carefully toward the contact point, and with it as much as possible of the remaining overhang should be removed, or as much as the limitation of movement will allow. The trimming knives can now be used, and should be followed by the files, with some care to guard against too much cutting; the needed contour and symmetry of shape must always be remembered.

Further smoothing is done with sandpaper discs and strips, followed by the usual polishing process. It is often necessary to carry the polishing

powders on linen tape over the proximal portion, in order to finish thoroughly.

In proximal fillings in the six anterior teeth, the first cutting is usually done with sandpaper discs and strips, although the corundum stones are material aids on both labial and lingual surfaces, especially the latter. It may also be necessary to use the saw, knives and files for the purpose of removing the gingival overhang; but they are perhaps not needed so much as in the posterior teeth. Polishing is done with cuttle-fish discs and strips, and with the powders. The incisal angle and edge, when involved in a filling, demand a greater use of corundum stones and sandpaper discs.

FIGS. 246. 247. 248.



Considered as a stopping, nothing as yet has quite taken the place of gold, although it cannot be said to apply perfectly to all cases. A full knowledge of its properties, behavior, and working qualities, is the first essential. With skillful instrumentation and bulldog persistence, one ought to be able to conquer the art of making nearly perfect gold fillings in a comparatively short time, say in from five to ten years.

Reference has been made to the discovery of the cohesive property of gold as marking an epoch in the history of tooth-filling. Another epoch may be said to have been ushered in by the scientific and artistic work of Dr. G. V. Black. The world wide influence exerted by this great worker may be noted in papers, reports of clinics, etc., published in the various journals by members of the G. V. Black Club (Inc.) of St. Paul. This organization has done much to simplify gold filling, and, in general, not only through its home meetings, but in state, national, and international gatherings, has done much to further the progress of operative dentistry.

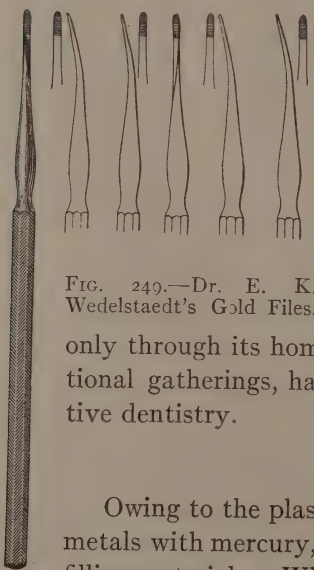


FIG. 249.—Dr. E. K. Wedelstaedt's Gold Files.

AMALGAM

Owing to the plasticity conferred upon an alloy of one or more metals with mercury, amalgam is usually spoken of among the plastic filling materials. What takes place in the union is the lowering of the fusing point of the alloyed metals by introducing mercury, a plastic stage thus ensuing before crystallization is complete. This plasticity and subsequent crystallization—both interesting phenomena—led to its introduction as a filling material.

The study of amalgam is somewhat complex because we have to deal with an alloy of certain metals not always constant in physical properties out of the mouth, and liable to still greater modification after introduced into the cavity as an amalgam. For various applications in the arts, metals are alloyed to gain specific ends not obtainable by any one of them alone: to increase hardness, strength, toughness, elasticity, and resistance to corrosion; to lower the fusing point; to modify color, etc.

Alloy making and application were known to the ancients, although they did not always produce what they intended to, nor did they know very much about the separate elements. Alloy for amalgam fillings was introduced in the first quarter of the last century. Things were done on a more or less empirical basis until the impetus of scientific method altered matters. Although formulas may not have changed markedly, there has been undoubted improvement as to certainty of procedures and results. It was the general lack of applied science which made it so difficult for amalgam to take its present place of usefulness, and we owe a debt of gratitude to all the zealous workers who have combined to give it that place. The early prejudice against it was due to its non-scientific composition and use. It is, perhaps, needless to say that amalgam has been criminally abused in the past, and that the better conditions which might naturally be expected from scientific workers have not been commensurate with their efforts. Its plasticity readily betrays operators into unwarranted speed—a fact which is only too soon recognized by the charlatan class.

Some properties of amalgam should be noted. Its color is grayish white. It is generally spoken of as brittle, although under certain conditions it manifests a degree of malleability known as "flow." It is harder than silver, but not very tenacious. Gases are condensed upon its surface to a larger degree than with gold. As to conductivity, all alloys have less of this property than do the simple metals. These properties are modified, first, according to the number and quantity of the various metals added; and, second, according to the mode of making.

As to the manner in which amalgam fulfills the requirements of a filling material: It may be said to be practically indestructible in the mouth. Chemical action of any kind is always more energetic in alloys, hence amalgam unites easily with oxygen and sulphur. In adaptation to cavity walls, it is nearly as good as gold. The change in form in amalgam, due to contraction and expansion, so noted in the past, has been reduced by modern science to the minimum. It withstands attrition well, and, in general, the forces of mastication are not so manifest upon well-made fillings of this material as upon those of gold. Its color is one serious drawback. Its conductivity is low, far lower than that of gold. As to ease

of manipulation, this property increases in proportion to the amount of mercury introduced in the alloy; but the operator must choose between this advantage and the superior one of firmness, for, if the latter be the desideratum, it must be had at the expense of the former. In susceptibility to polish, it fulfills the demand.

The properties of amalgam decide its application, to a large extent; for instance: its color limits its use to the posterior teeth, or where it is little noticed; the possibility of each manipulation often determines its use in cavities inaccessible to gold. So then, generally speaking, it can be used in the bicuspids and molars, especially in cases where more nearly perfect results can be obtained than by the use of gold. However, if exposed to view to any extent, it is contra-indicated. We may say that so far as it is peculiarly adapted to such selected cases, it becomes the ideal material.

If success is to be obtained in amalgam work, the following points must be carefully considered: The individual metals used; the purity and the proportion of the metals; the manner of production; and the manipulative procedure. The study of the chemical and physical constants of the metals is imperative. As to the behavior of metals toward one another in alloys, it may be said that mixtures are not merely mechanical. They are in the nature either of a solution of one metal in another, or of a chemical combination. A chemical combination may be a pure one, or it may provide an excess of one of the metals in which latter case the excess is mingled mechanically with the mechanically combined constituents. Proportion, temperature, etc., of course determine the final manner or manners of the combination.

There is no hard and fast rule regarding the reciprocal action of metals in alloys. Some metals alloy easily in any proportions; some less easily and in only set proportions; and again others alloy with extreme difficulty under any conditions. As a rule, metals of similar chemical nature have greater affinity as alloys than those which differ.

Mention should be made of the fact that only chemically pure metals ought to be employed. Otherwise, unaccountable variation will manifest itself.

The proportion of metals is of considerable moment. Experiments have shown that like quantities of metals alloyed alike produce certain results. Furthermore, the addition of a very minute quantity of some metals is capable of causing great modification in the properties of the resultant alloy. The manner of production is of tremendous importance, for instance:

If metals be heated to a temperature beyond the fusing-point, a different atomic grouping may occasionally result. The length of time they are kept in the fluid state, the mixing process, the various methods of cooling

and casting, may noticeably modify an alloy. In some cases when cooled slowly, they will separate into several alloys of differing compositions; that is, the alloys with a higher fusing-point solidify first. This is spoken of as liquation. At the same time specific gravity may manifest itself so that the lightest alloys, if solidified last, may be uppermost. If liquation takes place, there will be not only variation in composition, but also, to a marked degree, in the properties. Liquation should, therefore, be prevented as far as possible wherever constancy of properties ought to prevail. This can in the main be accomplished by rapid cooling.

It is clear then, that much depends upon the manner of production. The foregoing remarks may be made more clear by a description of the process of making dental amalgam alloy:

Take the formula 60 per cent silver, 35 per cent tin, 4 per cent copiper, 1 per cent zinc. To make 10 oz. we shall need 6 oz. silver, 3½ oz. trn, 8 dwts. copper, 2 dwts. zinc. Zinc is added in the combination of b ass, because free it is easily volatilized and oxidized. The brass, however, should be of known proportions, say 75 per cent copper and 25 per cent zinc (a constant alloy). The weight will then be 2 dwts. copper and 8 dwts. brass. The brass, copper, and silver are fused in a plumbago crucible first. The tin is fused in a separate ladle, and added as soon as the first three are in fluid condition. Fusing all the metals at once has been tried, and analysis and experiment show greater variation. Some stirring is necessary until the pouring out begins. A quarter inch steel mold about four inches wide cools the alloys fast enough. One out of every thousand melts, as above, were subjected to analysis by Prof. C. J. Bell in the chemical laboratory of the University of Minnesota. Five sections of the bar were made, and the percentage of each metal was very nearly the same in all, and according to formula.

If thicker castings be made, liquation is very liable to take place. The bar can be reduced by means of a twelve-inch bastard file, and strained through a brass wire mesh. Iron filings from file and bench vise may be removed by passing the magnet through for several minutes, and it is then aged by subjecting it to the temperature of boiling water for about twenty minutes; the mass is placed in a beaker, and introduced into a pot of boiling water.

The silver is added for its hardening and settling qualities; it also causes expansion. Tin is added chiefly to counteract the expansion caused by the silver, and to retard the setting. Copper increases hardness and strength, and has some effect upon color. Zinc heightens the color, and somewhat hastens the setting.

The percentages of dental amalgam alloys have been determined by experiment. For a detailed study of them the reader is referred to the

scientific investigations of Dr. G. V. Black (*Dental Cosmos*, Vol. 28, and elsewhere).

Dental amalgam alloys are classified as binary, ternary, etc., according to the number of metals added.

With amalgam the most vital point for consideration is the manipulative procedure. Not only is the percentage of mercury to be reckoned with, but also its incorporation, the compression of the mass, trimming and finish, are all elements that figure prominently in the results. One reason

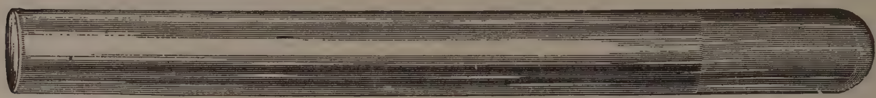


Fig. 250.

that this material has not reached a higher plane generally is a lack of sufficient study and attention to minutiæ and detail in the technique of insertion. This deficiency should be more widely acknowledged and repaired.

It has been the writer's privilege to observe several hundred amalgam operations made by Dr. F. H. Orton, of St. Paul, during the past twelve years. The results have been uniform, and as nearly perfect as are ever seen. His method of procedure is incorporated in the following description of filling a cavity with amalgam:

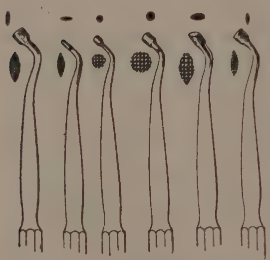


Fig. 251.—Black's Hand Pressure Amalgam Instruments.

The cavity is prepared as for gold, with this difference, that the enamel bevel should be somewhat longer. All cavities must be simple; if not so in the first place, they must be made so by adjusting a matrix to replace the missing wall. The matrix should be unyielding and fit closely to the tooth-surface. The amalgam is prepared by placing the mercury in the palm of the hand, and gradually adding the alloy until affinities are practically satisfied. The hand should be perfectly clean and dry. The incorporation of the ingredients is accomplished by rubbing with a glass pestle. (See Fig. 250.) Both judgment and skill are necessary to obtain the proper mix; a certain crepitus is noticed when the mass is about ready, and some experience will enable one to know when this point is reached. It should be an object to have as little surplus mercury as possible when the mixing is finished; therefore it is forced out in chamois skin or muslin with heavy pliers so much so that the mass should resemble a hard, flat cake which fractures sharply. In packing the amalgam the object is density and complete union of all the particles. As it is somewhat

plastic, the plugging points should be as large as the cavity will permit, and with serrated surfaces (see Figs. 251, 252, and 253). Hand pressure as ordinarily understood is not sufficient; hence the aid of the mallet comes in, using bayonet shanks as illustrated. It will be found that it requires a rather heavy blow from the mallet to compress the amalgam, and that the blows must be repeated until the mercury appears under the plugger point. This surplus mercury is then removed by the aid of gold foil, the two metals having a marked affinity for each other. A cylinder of gold foil is placed upon the surface, covered with spunk, pressed down and removed. More amalgam is then added, and the process is repeated until the cavity is overfull. Importance should be attached to the removal of the surplus mercury whenever it appears; if allowed to remain, it weakens the mass. If care is taken, the amalgam will be sufficiently crystallized to admit of trimming immediately. For occlusal surfaces large spoon excavators should be used, and for proximal, trimming knives and coarse cuttle-fish strips and discs. Fillings in other positions present few difficulties in trimming. The same instruments with some additional chisels or excavators for special inequalities will be found all-sufficient.

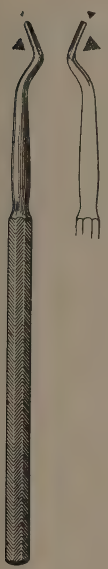


Fig. 253.—Owre's Right and Left Amalgam Instruments for use against Matrices at Junction of same with Cavo-surface Angle.

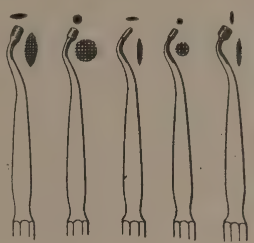


Fig. 252.—Black's Amalgam Instruments with Bayonet Shanks for Mallet Use.

It is best to postpone for a day the final polishing. First corundum stones, and then powders, are used, as in the polishing of gold fillings. Since in time these fillings undergo a slight change in form, it may be necessary to refinish afterwards, as occasion demands.

The time required to make a good amalgam filling is nearly that required for gold; therefore were it not for the fact that in certain cases it excels all other materials, there would be no economy in its use. Many large cavities may be filled with amalgam when the malleted gold filling would be entirely out of the question. Restorations of considerable magnitude are often made, whereby teeth are rendered useful for a number of years.

Although amalgam is not proclaimed as the acme of desirability, it occupies a very high place as a tooth saver, and it is well worth effort and energy to increase our knowledge concerning it. There is yet a wide field open to the investigator in alloy making and application. With

what has already been achieved, however, the student can and should thoroughly acquaint himself, and thus conserve time by eliminating the errors and profiting by the valuable discoveries of the past.

TIN

For various reasons tin is still used by some dentists, and the ability to insert a tin filling is a test in some official examinations. Hence this material should be studied.

In color it is white with a tinge of yellowish-blue. When pure it has a bright, metallic luster, and although in normal air it does not easily tarnish, it readily occludes gases. It is fifth in the order of malleability, foil $1/1000$ of an inch thin being obtainable by beating. It is classified with the soft metals, and is also of a low grade of tenacity, being tenth in the scale at 2.1 tons per square inch. Its specific gravity is 7.3. It is weldable in the cold state if perfectly pure, and purity generally implies fresh-cut surfaces. When weldability has been interfered with by exposure to air, it cannot be restored by annealing. As to conductivity, tin ranks low: For heat, 154; for electricity, 114.

Tin has been used as a filling material for a century or more; but it only partially fills the requirements of this purpose. It oxidizes readily in the mouth, is easily adapted to cavity walls, and undergoes no change in form unless subjected to wear, and, when so, the malleability and softness markedly manifest themselves. Its color is objectionable. So far as conductivity is concerned, it is low enough to be of value. The manipulation is very much like that of gold. It receives a fairly good polish. Occasional reference has been made to its therapeutic value, when used as a filling, as a preventative of caries, etc. This seems highly improbable, excepting insofar as it replaces the carious area, as does any other filling material.

Tin has been recommended for cavities which are not exposed to wear and tear, and is practically limited to simple smooth-surface cavities not exposed to view or wear. It may have some application to cases of young children, owing to its rather easy manipulation.

It is prepared for the dentist in several forms, but the foil is chiefly used, between Nos. 3 and 10. But, as this soon loses the property of cohesiveness, the dentist had better prepare the shavings of tin himself, when wanted, by casting an ingot upon a polishing mandrel, attaching to lathe, and, with a sharp tool, cutting as fine shavings as desired for the case in hand.

Its insertion is exactly according to the method pursued with gold, the only difference being that the plugger points may be more deeply serrated. The finishing, also, is the same as in the case of gold.

Since science has aided us in establishing the status of things, it would seem as if the future of the tin filling were somewhat dubious. Personal opinion need not obtrude itself here, for speculation belongs only to the field of theory.

THE SILICATES

The silicate cements have now been in use a sufficient time to give some indication as to their value in dentistry, and yet it is very evident that no one can with certainty predict their ultimate status as a medium for saving teeth. Two things are today evident—that it is not safe to claim for silicate cement that it is a permanent filling material in the same sense that are gold foil, amalgam or inlays; and that on the other hand, there are very few operators who would care to be deprived of the use of this material after they have once employed it. What then shall be said of its status? Merely that it is a very useful material under its proper indications, and with a full recognition of its limitations. In certain positions and under certain conditions it has been known to do good and satisfactory service for years—a service which could not have been so acceptably performed by any other material. This of itself should entitle it to much consideration, and yet its limitations are so great that unless they are fully recognized there will be much disappointment following its use. The fact should be emphasized at once that this material is not sufficiently strong or tough to withstand the stress of severe usage in the mouth, and that whenever it is placed in positions where stress is brought to bear, its failure is inevitable sooner or later.

Its chief claim to consideration relates to the fact that by its expert use a better match for the teeth may be made than by any other means at our present command. It can be blended so perfectly with the natural enamel as to defy detection at conversational distance from the patient, and the line between the filling and the tooth which is often apparent when porcelain inlays are used is entirely eliminated. The perfection of results so far as appearance is concerned, makes it a most attractive material to use in the anterior part of the mouth, and unless the operator exercises good judgment in recognizing its limitations, he is quite likely to become so fascinated with the material as to use it under circumstances where it is almost certain to result in failure.

Indications.—This material is indicated in all positions exposed to view and where there is little or no stress. It has its chief range of service in the labial surfaces of incisors and cuspids in cavities with surrounding walls where the problem of anchorage is very simple. It has not the same tenacity to the walls of cavities as has the oxyphosphate of zinc or copper, and provision must therefore be made for its mechanical retention in

cavities. In simple proximal cavities in the anterior teeth it sometimes serves a useful purpose so far as appearance is concerned, although it is usually not very permanent in these cases. In all those situations where appearance is paramount to permanency the operator is justified in using silicate cement provided he states frankly to the patient the probable temporary character of the work.

It may be used to good advantage in certain cases where the incisal angle of an incisor is missing by making a gold inlay for the restoration and cutting out the labial surface of the inlay and covering the gold with silicate. This makes an operation of good appearance, and if the silicate wears away it is a simple matter to renew it occasionally. Many patients prefer to have this done rather than to have the gold show, or to have the discolored line between porcelain and enamel.

In the daily routine of practice it probably has its most useful field in emergency service. No material that we have ever had will meet the situation so acceptably as will silicate cement in certain of the exigencies which arise in the experience of every practitioner. If the buccal cusp of a bicuspid fractures off as to leave a conspicuous gap in the mouth, there is no material by which the practitioner can so readily repair the breach and make the mouth presentable as by the use of silicate. It will relieve the immediate dilemma and tide the case over until a more permanent operation can be made.

Another unfortunate accident which frequently leads to embarrassment is the fracture of a porcelain facing on a crown or bridge. Nothing in the mouth is more conspicuous than this, and it is imperative to resort to some ready means of repair to meet the emergency. Silicate cement will do this more quickly and acceptably than anything else, and a very awkward situation is relieved in a few minutes. Time can then be given for a new facing of porcelain, but let it be said in this connection that there are many cases on record where both the bicuspid operation and the facing operation have proved so satisfactory that the patient has refused to have anything further done, with the result that these emergency operations have stood for years. It seems to be one of the peculiarities of silicate that no one can predict just how well it is going to last. In some cases it gives a very wonderful service, while in others with apparently the same kind of manipulation, it proves discouragingly temporary.

Manipulation.—Silicate is deleteriously affected by the use of steel instruments, and must be manipulated with some other material. Probably the best spatula with which to mix silicate cement is one made of agate. This will not affect the material and it is readily kept clean. This introduces one of the most important considerations in manipulating silicate—the necessity of perfect cleanliness. With no other material is

the admission of particles of dirt or dust more disastrous than with this. The filling instruments may be made of tantalum, which is not affected by contact with the material, and which can readily be kept clean.

The operator should study very carefully the blending of shades so as to be able to match with perfection the various colors of enamel found in the natural teeth, and as has just been intimated, the possibilities of doing this so as to defy detection forms one of the chief claims of this material to our consideration.

After the filling has been placed in the cavity and trimmed to form, it should be kept dry for a few minutes, and then covered with a varnish to exclude the saliva. At another sitting, if the surface of the filling is not satisfactory, it may be trimmed with disks or strips and polished; but frequently it will be found that after crystallization has taken place the surface of the filling will present a vitreous or glazed appearance which is preferable to anything which can be produced by polishing, and so it should not be disturbed.

If silicate is used with discriminating care and under its proper indications, it will serve a very useful purpose, but if employed without judgment it will bring disaster to the operator and disappointment to the patient.

CEMENT

Among the applied arts, cement, in its various forms, has been in use for centuries. Its introduction to dentistry did not occur until about fifty years ago. Largely owing to lack of science, it has had a degree of difficulty in establishing itself as a filling material, as also had amalgam. For that matter, its *status quo*, all told, is still somewhat doubtful. Nevertheless, it serves many important and useful purposes—so much so that we have come to regard it as indispensable.

Of the three kinds of cement to be considered, *i.e.*, the oxychlorid of zinc, the oxyphosphate of zinc, and the oxyphosphate of copper, the first is at present little used. The use of zinc oxychlorid as "a stopping of hollow teeth" was first suggested because of its plasticity when freshly mixed, its subsequent hardening, and its apparent indissolubility. Its shortcomings were soon discovered, and various modifications of the powder and liquid were tried for the purpose of enhancing its qualities, but to no avail.

The oxyphosphate of zinc, introduced some years later than the oxychlorid, gave promise of greater things. It has largely taken the place of the oxychlorid, except for some special purposes to be noted. Upon it our main reliance was placed until the late Dr. W. V-B. Ames, of Chicago, brought out the oxyphosphate of copper.

Some general properties of all cements should be noted: Plasticity,

facility of setting, granular structure, low strength, porosity, marked solubility, and low conductivity. As to color, the oxychlorid is nearest white, the zinc oxyphosphate has various hues, while the copper oxyphosphate is the blackest of black. The properties vary a great deal, according to composition and modes of mixing, especially those of density, setting, porosity, permeability, disintegration, etc.

To a certain extent all cements possess the essential qualifications for a filling. But they are not indestructible in the fluids of the mouth, especially under the free margins of the gum. The oxychlorid is the worse in this respect. Their adhesiveness to cavity walls is of great value. Some cements undergo change in form, particularly through contraction. None resist attrition well, although oxyphosphate of zinc and copper wear much better than the zinc oxychlorid. As to colors, highly artistic results may be obtained with some of them, but the black of copper oxyphosphate limits the application of it to unexposed places. Cements are practically non-conductors of heat, and are often indicated for this reason. As to ease of manipulation, they are undoubtedly first of all materials. They are incapable of receiving or maintaining a very high polish; although when first finished the surface may be fairly smooth, with wear it soon becomes granular. Some of them are, in general, less irritating to tooth tissue than metallic fillings, and this is one of the most important considerations. Oxyphosphate of copper has been found to be extremely bland when used near the pulp, or even in contact with gum tissue. In regard to the porous structure, this is capable of some reduction through modification of constituents.

Turning to indications for the use of cement: At present the oxychlorid is not used to any extent as a filling for the entire cavity, because of its speedy disintegration, and the irritating character of the chlorid. Many authorities agree in indorsing it as a cavity lining because of its white color, its density, and therapeutic value. It should not be used too close to the pulp, because of the irritation likely to result, but it may be used to advantage in pulpless teeth for the larger portions of the canals and fill the pulp chamber.

We are considering then, practically, only oxyphosphates of zinc and copper. Fillings prepared from these materials are spoken of as temporary, it being implied that they will be replaced sooner or later by more nearly permanent ones. While this is correct, we must not lose sight of the fact that some teeth will never be filled with anything more permanent, *i.e.*, cement seems peculiarly and preëminently to lend itself to the preservation of certain teeth. It is, *par excellence*, the material for use in all cases where for any reason no adequate cavity preparation can be made for the so-called permanent fillings.

It is also indicated in some other cases: Those of very old people, and those of younger people in whose teeth caries is acute. In the latter case it is introduced as a temporary filling in the true sense of the term, in extending the usefulness of frail or deciduous teeth.

In discussing the preparation of cements, we are confronted with the large and insurmountable trade-secret proposition. The mere names indicate some of the chief ingredients; but of the various methods of production, the modifying agents used, etc., we have very little data. As it comes to the operator's hand, a cement is made up of a powder and a liquid. The powder of the oxychlorid of zinc is composed chiefly of oxid of zinc, calcium oxid being often added to hasten setting, and other ingredients to obtain certain other properties, as silicate of aluminum, magnesium oxid, sodium borate, silex, powdered glass, etc.

The oxyphosphate of zinc is principally composed of glacial phosphoric acid and zinc oxid, to which are added, for the purpose of increasing hardness and lessening solubility, several foreign ingredients, *e.g.*, sodium phosphate gives the liquid a glassy consistence in handling. A chemical analysis of cements shows the following impurities:* Arsenic, antimony, lithium phosphate, cadmium sulphid, carbon, fluorhydric acid, nitric acid, sodium carbonate, powdered glass, silex and water glass, sodium borate, magnesium oxid, magnesium nitrate, sodium phosphate, silicate of alumina, phosphate of alumina. The fineness of the powder varies not only with different makes, but occasionally with different lots put out by the same maker. The finer it is, the quicker it sets.

The oxyphosphate of copper is composed of the same liquid as the foregoing, and cupric oxid, with or without addition of other metallic oxids.

The preparation of cements for filling cavities is not very difficult, but some care is necessary. The phosphoric acid has a tendency to crystallize. To lessen this, Dr. Ames recommends keeping it in a telescoping glass cap bottle, instead of one with the cork fitting within the neck. The prime requisite in mixing is thorough spatulation. Powder should be added to the liquid in only a small mass at a time, and before use the mixture should attain a putty-like consistency.

In the case of oxyphosphate of copper, a creamy mix seems to give best results. It should be needless to say that the glass slab, spatula, and other instruments used in handling cements must be scrupulously clean and well polished.

Cements vary somewhat in their working qualities. Hence, good results can be made sure of only by more or less experience.

The cavity preparation for cement fillings is simplicity itself, since the adhesiveness of the material may be very largely depended upon

* Dr. J. E. Hinkins, *Dental Cosmos*, Vol. xliii, p. 591.

for securing the filling to the cavity walls. The complete removal of caries should in every case be insisted upon, however. In inserting the material, one must remember to overfill the cavity, and to use as nearly as possible even pressure from all points. For this work broad, flat burnishers are usually employed. These should first be rubbed upon an oil-pad to prevent the cement from adhering to them. The filling should then be left thoroughly to crystallize before trimming, which process is accomplished with chisels, trimming knives, and occasionally burs. A fairly smooth surface may be had by the aid of fine sandpaper discs or strips.

The cement operation, with proper care, may be made a very successful one. That it has fallen in estimation somewhat, is due largely to the fact that the apparent ease of cavity preparation and of manipulation lend themselves to charlatanism. Used by skillful hands in the proper places, cement has, in spite of its lack of durability, a valid claim to a position among filling materials.

GUTTA-PERCHA

The name *gutta-percha* is applied to the inspissated juice of various plants belonging to the natural order Sapotacea. The term is of Malayan origin, *gutta* signifying *gum*, and *percha*, the species of tree from which the gum is derived. It is native in the Malay Peninsula, and although its use has long been known in the Orient, even back into antiquity, it was not introduced into the western world until early in the last century, when its great possibilities in the realm of manufacture were recognized. It was taken up by dentists about 1850, and, according to Dr. J. Foster Flagg, it was then suggested as a temporary stopping for frail teeth, and was recommended for its ease of manipulation, its non-irritating and non-conducting character, its insolubility in the fluids of the mouth, and its reasonable resistance to attrition. He further asserts that with it he could make better fillings in certain places than with gold. Various modifications of it were introduced better to meet the dentist's requirements. But the difficulties attending its manipulation, its non-resistance to attrition, and the gradual gain of cement, have lessened its use. Lastly, the introduction of copper oxyphosphate has almost crowded it out as a filling for the entire cavity.

The properties of gutta-percha are its decidedly low conductivity, its blandness, or non-irritating character, its agreeable color, and its insolubility. It lacks hardness, even when foreign substances are introduced to increase this property. Its contraction on cooling is also an objection, as is also its more or less porous structure. It is insoluble in the fluids of the mouth; it can be reasonably well adapted to cavity walls; it changes in form, notably by contraction; it does not resist attrition; its color is not

objectionable and is easily modified; it is the best material we have for non-conductivity; it is not so easy of manipulation as cement; it takes no polish at all.

Gutta-percha is indicated wherever a perfect non-conductor is needed; but as it cannot be used in any place where it will be subjected to attrition, it is decidedly limited in its application. It is especially applicable to the filling of small pulp canals in pulpless teeth.

Commercial gutta-percha is prepared by boiling and purifying in a number of ways. When nearly pure, it is of a grayish-white color which can be modified as desired. For dental uses the pink base plate gutta-percha seems to be best. It is colored by means of sulphide of mercury.

Its successful use involves considerable skill. It must be heated until soft enough to permit of its being adapted to the cavity walls. In this process it must never come in contact with the open flame. Various devices are employed for heating, such as porcelain trays to be held over the flame, or sand-bath. If overheated it is ruined. Ordinarily the instruments used are flat burnishers which should be warmed and oiled. The cavity should have some retention form, and it is also well to coat the cavity walls with oil of cajeput or eucalyptus. Dr. Black remarks that these oils take strongly to cavity walls, and also slightly dissolve the surface of the gutta-percha, hence their value.

The material is packed piecemeal into the cavity, or *en masse*, care being taken to insure thorough adaptation. One should guard against obtaining too much surplus, for gutta-percha does not lend itself so well to trimming and finishing as do other materials, although surplus can always be removed by the aid of a warmed burnisher. Or, when it has sufficiently hardened, it can be trimmed with thin, sharp trimming knives, always cutting from center to periphery.

That gutta-percha has possibilities is undoubtedly true. It will in all probability be continued in use for some time to come. But, if personal opinion were not out of place, we might close this discussion by observing that the attitude of the dental world seems to the present writer to be that gutta-percha as a filling material for the entire cavity, all things considered, is distinctly altered since the virtues of copper oxyphosphate have been fully made known.

COMBINATION FILLINGS

The term "combination fillings" has been made acceptable by usage, although it is not in all cases strictly accurate.

The fact that no one material possesses all the virtues desired, together with other reasons, as, for instance, the greater ease with which particular parts of the same cavity lend themselves to particular materials, have led to frequent indication of more than one material for the filling of the

same cavity. A few of these will be taken up for discussion, although it must be remembered that endless combinations may be made, according to the necessities of the case, and the ingenuity of the operator.

Platinum and gold are used together, chiefly for resulting color and density. Platinum is bluish silver-white in color. Its specific gravity is 21.46. The color of the combination varies between light and dark gray, depending upon the quantity of platinum used. This platinum-gold combination withstands attrition better than gold alone. For esthetic reasons it is indicated in cases when patients are of dark complexion. It is also desirable when more density is sought than gold alone can supply.

Platinum-gold for filling is used in the forms of folds of both metals, of platinized gold folds, and of platinum and gold foil. It is best not to use it for the entire cavity, a surface of this composition being quite sufficient. Generally speaking it is manipulated in the same manner as gold alone; but a little more care is called for in annealing and condensing. That is, it is easily overannealed, and a small condensing-area plugger point should be used and moved only its own width each time, thus insuring thorough condensation. It may be worth nothing that this serviceable combination of platinum and gold has of late been replaced largely by the porcelain and gold inlays—the porcelain inlays chiefly in the anterior teeth, and the gold in many cases where great surface is to be restored for the purpose of resisting attrition.

The properties of *gold and tin* have already been considered. Tin has been used to fill part of a cavity, the finishing of which is done with gold. Tin was largely applied in proximal cavities to cover the gingival wall, in the same manner as non-cohesive gold; but this operation is practically discontinued, owing to what seems to have been a dissolution of the tin.

One method of preparing tin in this connection is to take it in sheet form, superimpose it upon a sheet of gold, cut to desired widths, and make into cylinders, as described under "Gold." A few operators use this combination in occlusal cavities in deciduous teeth, and in the gingival third of bicuspids and molars in the adult teeth to a limited extent.

It is handled in every respect like non-cohesive gold. It is undoubtedly true that this gold-tin filling may conserve certain teeth; but recent investigation has led to the improvement of amalgam and its consequent preferment over the gold-tin combination in many cases where the latter might formerly have served. Also, in the gingival portion of cavities there seems to be an increase in the use of non-cohesive gold alone; so that, on the whole, the outlook for this combination is not the most encouraging.

The *gold and amalgam* combination is, at times, of great value, amalgam being used either to fill inaccessible parts of cavities, as below the gingival line, or merely to lessen the bulk of gold in very large cavities. In complex cavities it is often admissible to fill, for instance, a disto-occlusal cavity with amalgam, and the mesio-occlusal with gold, making a step into the amalgam.

Gold and Cement.—Besides using the cement for its inherent virtues, it is also employed to lessen the bulk of gold in large cavities and in pulpless teeth.

The *amalgam and cement* combination is used similarly to the foregoing. Cement is also used in amalgam operations to strengthen weak walls, in which case it practically becomes a cavity lining. Frail teeth can often be thus preserved for a remarkably long period.

Cement and Gutta-percha.—Owing to the fact that gutta-percha is not soluble in the fluids of the mouth, it can be used in the gingival portion of proximo-occlusal cavities, cement being employed, since it is somewhat denser, for finishing the rest of the cavity. In general, it is not advisable to let metallic fillings rest upon gutta-percha, owing to lack of firmness in the latter; but a cement intervening will afford the proper support.

It is difficult, if not impossible, to acquire from a text-book the art of filling teeth, be the text ever so explanatory and complete in detail. Theory must be supplemented by practice. To strike an even balance in this respect is a task of some proportions. In filling teeth, we imitate the work of others. Possibly we perfect a detail here and there, make a new discovery, or improve a method. The imitative aspect of the profession predominates, however. But this should not discourage us. All told, the world we live in is an imitative one, the absolutely new things discovered from decade to decade being very few indeed.

Although his technique may have been revolutionized, the art of the sculptor has not changed since Phidias wrought upon the Parthenon or that unknown and remoter hand carved the Sphinx's features in the Valley of the Nile. The bases of the arts do not shift with the years; that which is of permanent value rests upon solid foundations like those of the Sphinx or the Pyramids amid their waste of unsteady soil. That which is good abides, and our own virtues may be measured according to the degree in which we show ourselves appreciative of the virtues of those who have laid our professional foundations.

We might say that we have now reached a certain stage of perfection in the preparation of cavities in teeth, and also in filling them with gold and other materials. Such advancement as has been made should be rigidly maintained. We should not, however, be content to rest upon

achievements. We must keep the mind receptive to possibilities, and the hand pliant and supple to slowly evolved technical inventions.

We have often seen and heard emphatic statements from operators to the effect that gold is the ideal and only filling in all cases, and that they use nothing else. Such statements are misleading to beginners who many times take them too seriously. Experience soon teaches that one cannot successfully adapt gold to all cavities. But the question, "what is the best filling?" implying that one material for all cases is possible, will often be heard from both scientific and unscientific people. Of course, the question cannot be answered as it is put. The whole of the foregoing chapter demonstrates this. An attempt at least has been made to elucidate the fact that any one of our materials is the best one for the special uses to which experience has taught us its properties have peculiarly adapted it.

But supposing that we were actually limited to a choice of one kind of material. In that case we might, perhaps, choose what, in dental parlance, is known as the *gold inlay*—cemented into the cavity. A discussion of this appears in Chapters XIV, and XVII. This supposition, although quite imaginary, tempts speculation.

Each material should receive the highest possible attention from the operator as it comes into his experience. The object should always be to perfect oneself in the intelligent application and manipulation of materials; and this can best be done by regarding each, as it is indicated, as the ideal. This, indeed, it is, when once its properties are found to harmonize with the needs of the case under treatment.

In closing, perhaps it is well to reiterate that increase in technical proficiency is stimulated if accompanied by growth in a general understanding of the eternal fitness of things—an appreciation of proportions and harmonies, not only in our own specialized branch of the great world of science and art, but in all that we can, by industrious study, bring from that world within the range of our intellect. The whole world of artistic endeavor—literature, music, design, painting, sculpture—every division of the industrial and liberal arts—teems with lessons for the worker in so exacting and delicate a profession as that of dentistry. "It is all triumphant art, but art in obedience to laws." Dentistry itself, regarded in its true light, must, in the minds of intelligent operators, come to be regarded as not the least among modern arts and sciences.

For one who acknowledges allegiance to this broader supremacy, the practice of our profession should, so far from narrowing a man's powers, continually expand them, and afford more and more intellectual satisfaction as he progresses towards the ultimate ideal of perfection.

CHAPTER XIII

THE USE OF THE MATRIX IN FILLING TEETH

BY LEWIS E. FORD, D. D. S., F. A. C. D.

The function of the matrix in filling teeth is to supply the missing wall in those cavities involving two or more surfaces of the tooth, one or more of whch is the proximal surface. It is axiomatic that cavities with surrounding walls are more readily filled, other things being equal, than those where there are only three walls facing an open space, and thus the matrix is used to provide a wall against which the filling may be built.

INDICATIONS

Formerly many eminent operators employed the matrix in the insertion of gold foil in large proximo-occlusal cavities in molars and bicuspids, particularly in disto-occlusal cavities, but in recent years since such cavities are quite generally filled with inlays instead of with foil it is very rare that the matrix is indicated in the insertion of foil. Most of the foil fillings that are inserted today are in simpler cavities that do not call for the use of a matrix.

The chief indication for the matrix then relates to its service in the insertion of amalgam, principally in the restoration of molars and bicuspids where large portions of the tooth have been lost. In these cases it is of the greatest service and may be made to answer a most useful purpose.

KINDS OF MATRICES

Various makes of matrices are on the market, made mostly of thin steel, and the operator may select the one which appeals most to his individual requirements, but for the widest range of service a matrix made by the operator himself for each case will answer the best purpose. Thin German silver, such as may be procured at the dental supply houses, is an excellent material with which to make matrices. A strip of the proper width is selected, and wrapped around the tooth to be filled. With a pair of pliers the two ends are grasped as they extend buccally, and the matrix snugged up to the tooth as is desired. When the matrix has the proper form it is slipped off the tooth and the ends tacked together with soft solder, and trimmed smooth so as not to irritate the cheek

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of the patient. Or the ends may be lapped one over the other and fastened together by punching them with matrix pliers made for this purpose. All of this can be done in a minute or two. When the matrix is made it may be slipped over the tooth and pressed with a ball burnisher to the proper form to give the requisite contour to the filling. If the matrix stands away from the cavity at the gingival so as to leave too large a space it may be pressed to position by packing some gutta-percha between it and the adjacent tooth in the interproximal space.

Another method of making a matrix is as follows: Take 36 gauge sheet copper and cut a strip long enough to lap the tooth about ⅛ inch on the buccal and lingual surfaces beyond the cavity margins and a little wider than the distance between the cervical margin and occlusal surface of the filling as it is to be finished. Anneal by heating to a cherry red and dipping in water. This will cause the copper to be more pliable and also serve to sterilize it. This partial band is now shaped around the tooth, and the location of the contact point is ascertained and marked, and a hole drilled through the matrix with a No. 4 bur. The margin of this hole is then beveled in the cavity side of the matrix by taking a small stone and bringing the margin of the hole to a knife edge. Then when the band is held in place by ligating or by the use of separators, the amalgam will be forced through this hole into intimate contact with the approximating tooth. Also, to assist in the final removal of the matrix, if a cut is made with a pair of scissors from the cervical margin to the contact hole, the buccal and lingual ends may be spread by an outward and inward pull, either up or down as the case may be according to whether it is an upper or lower operation, and that portion of the matrix which is cervical to the contact point may be removed through the embrasure, and thus not endanger the contact point or filling contour. When ligatures are used to retain the band, if the end of the band at the cervical margin is turned up, it will greatly assist in keeping the band in place. In ligating the matrix it is often necessary to use two or three turns of waxed ligatures to hold it in position, and also to secure it by the use of the surgeon's knot. Gutta-percha, orange wood wedges, cotton or spunk may be used to pack into the interproximal space so as to hold the matrix in close proximity to the cervical margin. Due care should be used if it is found necessary to do this packing to cause no injury to investing tissues as this is very easily done if such care is not taken. This will prevent an excess amount of material from extending as an overhang at the cervical portion of the filling.

In the insertion of the filling great care must be exercised to carry the filling material well over the enamel margin between the matrix and the margin to ensure a perfect covering of the filling over the enamel, and

permit of a proper carving and polishing. Unless care is taken in this particular there is likely to be a crevice between the filling and the enamel when the matrix is removed.

It is sometimes advisable to leave such a matrix on the tooth until the next sitting in case amalgam is being used, to allow the filling to become thoroughly crystallized. If the matrix is removed at the same sitting there is danger of disturbing the contour of the filling before crystallization is complete, and there is also the possibility that the patient may injure such a filling by inadvertently using it while it is yet more or less soft. It is seldom possible to slip such a matrix off the tooth without cutting it, because of the contour of the filling at the contact point.

After the removal of the matrix there is little trimming of the filling called for, provided care has been exercised in giving the matrix the proper form. It is, therefore, necessary only to go over the filling with a strip or disk and dress it, smooth and polish it.

To take advantage of the great aid afforded by the matrix in the insertion of large contour fillings is to remove from these operations one half of their difficulty, and to ensure better results. The principle of the matrix is correct, and when properly applied there can be no question of its great value and efficient service in the restoration of badly broken down teeth. If the profession had risen to the possibilities of the matrix and had availed itself of its widest range of usefulness, there would have resulted many more amalgam restorations on molars and bicuspids, and fewer gold shell crowns. And this would have been better for the patients.

CHAPTER XIV

INLAYS

BY C. N. JOHNSON, M. A., L. D. S., D. D. S., M. D. S., F. A. C. D.

The Principle.—To repair a carious or abraded cavity in a tooth by the inlay method the operator adapts a piece of heavy foil, either platinum or gold, to the cavity so that it fits perfectly, thus reproducing the form and outline of the cavity in metal; and in the matrix so formed, removed from the mouth, he builds a filling of porcelain or gold and cements this in the cavity. In the more recent developments in gold inlay work a wax model is made in the cavity, and this is reproduced in gold. The principle is different from that of the ordinary filling, the latter being adjusted piece by piece into the cavity in the tooth, the entire operation being performed in the mouth; while with the inlay much of the work is done outside the mouth and without the necessity of the patient's presence. This is a very great advantage of inlay work and has led in a large degree to its popularity. The relief from the tedium of long and sometimes painful sittings has been a source of great satisfaction not only to the patient but to the operator as well. There is less nervous tension and altogether a greater measure of comfort in doing inlay work than in such operations as large gold fillings, and this phase of the subject has appealed very strongly to patients.

INDICATIONS FOR THE USE OF INLAYS

That inlays have become an important factor in reparative processes in operative dentistry there can be no question. There is still some difference of opinion as to the precise range of their applicability, but for certain well-defined cases their utility is no longer in doubt. It must, therefore, be apparent that no dentist can practice to the best advantage for himself and his patient without an understanding of this work. There are many cases of affected teeth that can be better preserved by this than by any other method. In cases of extensive decay it may frequently be made to save a tooth which otherwise would be condemned to crowning, and on general principles the longer a tooth can be saved without a crown the better it is for the patient.

From the nature of their method of manufacture inlays are restricted in their use to cavities which will admit of the matrix or wax being inserted

and removed without distortion, or cavities which may be made of such a form without an unwise sacrifice of sound tooth tissue.

Porcelain inlays are indicated chiefly in cavities exposed to view in talking, laughing, or singing. It should be the highest aim of art in dentistry to conceal the evidence of our operations from public view, and the conspicuous display of gold so frequently seen in the anterior teeth of patients speaks of a lack of taste which is something of a reflection on the profession. Fortunately this display is less prominent than formerly, and this in large measure is due to the introduction of porcelain inlay work. With porcelain an operation may be made which is not conspicuous at conversational distance from the patient and in some instances the porcelain may be shaded to match the enamel so perfectly as to defy detection even on reasonably close observation. This is a great step in advance so far as the art side of our calling is concerned, and every dentist should equip himself to take advantage of it.

But this work has its limitations which should be recognized by every conscientious operator. The physical characteristics of porcelain are in some respects very much against its extended use, particularly in positions where the stress of mastication comes forcibly upon it. Porcelain is brittle and will fracture easily. It is therefore contraindicated in cases where the filling must be made with thin margins or in small bulk. It is true that in the anterior part of the mouth where esthetic considerations are very important it is frequently justifiable to take some chances of its fracture and place it in positions of prominent exposure even with some risk of failure. Patients are often willing to take this risk for the sake of the improved appearance over any kind of a metal filling, and where there is a perfect understanding between operator and patient as to the possibilities of failure porcelain may be given a rather wide range of application in the anterior teeth. Porcelain inlay work has not been sufficiently long in general use to afford the necessary data upon which to base reliable judgment as to its probable permanence, and in many of these cases where great risk was apparently taken the service of the inlays has been surprisingly satisfactory. It may also be stated that in many other cases where the same care has been exercised in their manufacture, and where conditions would seem to favor their utility they have proved a grievous disappointment. It is this element of uncertainty with inlays which has made many of our conservative practitioners look with disfavor upon the work, and yet their demonstrated utility in so many cases is sufficient to argue strongly in their behalf.

It is probably true that much of the failure has been due to imperfect methods of manipulation and to a lack of knowledge of the underlying principles of the work, as well as to faulty technique in carrying it out.

Another uncertain factor has been the cement. This material has proved itself peculiar in its behavior under varying conditions and some of its peculiarities have not been well understood. In addition to this, much of the cement used for inlay work in the past has been made for fillings and for cementing crowns without regard to the peculiar requisites for inlay work. Neither have the correct principles of cavity preparation for inlays been generally recognized or put in practice.

In short the work has had to pass through the experimental stage of a new line of effort and has suffered accordingly, but these factors of failure are rapidly being eliminated and we may confidently look forward to more assured success since the principles are being better understood and the technique systematized; though with porcelain inlay work it must not be forgotten that it will always have the one serious limitation of friability of the material itself.

Gold inlay work has a much wider range of usefulness so far as serviceability is concerned than porcelain on account of its great strength, and it should be used quite generally wherever inlay work is indicated in places not exposed to view. Gold may be made to protect frail walls of enamel if necessary and the material itself may be extended into thin margins without danger of fracture.

To specify the particular classes of cavities where inlay work is indicated and draw a distinct line of demarcation between the indications for fillings and inlays is difficult, owing to the varying conditions which are presented in different cases. The preference of the patient must sometimes be considered, though it is not well to allow a whimsical prejudice to influence the operator to do a certain class of work under conditions where it is manifestly contra-indicated. It may be said in general that porcelain inlays are indicated in all cavities exposed conspicuously to view in cases where esthetic considerations are very important, such as cavities in the labial or buccal surfaces of incisors, cuspids and bicuspids, cavities in the proximal surfaces of those teeth where there is much exposure, and in contour operations involving two surfaces where a display of gold would be objectionable.

In recent years the use of silicate cements has somewhat displaced porcelain, and the tendency seems constantly in that direction. The improvement in the silicates, and the more satisfactory appearance of the margins of such fillings over porcelain inlays has led many operators to practically discard porcelain in their favor. There is no question that a more artistic filling may be made with the silicates than with porcelain, but so far as wearing properties are concerned the former cannot be compared with the latter. It is hoped that with the constant improvement being made in the silicates we shall eventually have a plastic material

which will be sufficiently permanent to render the somewhat difficult technique of making porcelain inlays less necessary.

Gold inlays are indicated in large restorations in bicuspids and molars, in cavities far back in the mouth where the problem of inserting an ordinary filling is difficult, and cavities in the buccal surfaces of molars where the decay has extended under the free margin of the gum. Employed in these cases gold inlays are very useful and may be given a wide range of service, but this will still leave a large class of cavities where the ordinary filling has its legitimate field and where no inlay can do equal service.

CHAPTER XV

PREPARATION OF CAVITIES FOR INLAYS

BY C. N. JOHNSON, M. A., L. D. S., D. D. S., M. D. S., F. A. C. D.

When inlays were first introduced the general impression given the profession that the adhesive properties of cement could be relied upon to hold the inlay in place irrespective of much depth to the cavity led to the formation of cavities too shallow and with insufficient attention to the principle of mechanical anchorage. Inlays should be anchored upon the same general mechanical plan as fillings, the only difference being in the details. It will of course be recognized in the beginning that cavities for inlays must be so formed that the mâtrix or wax may be lifted from the cavity without distortion, and this idea being prominent in the mind of operators caused them in many instances to make the walls of their cavities too flaring, with the orifice much wider than the interior. This resulted in attenuated edges to the inlay and frequently to a lack of definiteness of form, leaving the cavity more or less saucer-shaped. This is wrong in principle and has quite generally proved a failure in practice. Cavities should be made with some depth and with walls so formed that the inlay will remain seated without tilting or rocking under pressure even before it has been cemented.

In opening up cavities it is true that there are many cases where the orifice must be quite widely extended to admit of entering a matrix or wax into the cavity and removing it. This often involves cutting much sound tooth tissue, particularly in proximo-occlusal cavities in bicuspids and molars, where the decay in the proximal surface may have extended much wider bucco-lingually in the gingival region than it has nearer the occlusal surface. It will be seen at once that to fit a wax model to such a cavity it must be extended bucco-lingually very freely at the point where the proximal surface joins the occlusal to bring it on a line with the cavity further rootwise. The practitioner who purposes using inlays in these cases must have the will to cut quite extensively, and there are many instances where the loss of sound tooth tissue is so very great that the discriminating operator will decide upon inserting a filling instead of an inlay. This is one factor in the choice between inlays and fillings which has not received sufficient consideration. While it is true that in the preparation of cavities, whether for inlays or fillings, we are frequently called

upon to remove sound tissue for better access to the cavity and to establish marginal outlines at points where recurrence of decay will not take place, yet it is unjustifiable to sacrifice large portions of sound tissue in locations of practical immunity from decay in order to bring the cavity within the requirements for inlay work. In many of these cases a filling may be inserted to better advantage and with less injury to the tooth.

One cardinal principle in the formation of cavities for porcelain inlays is that they should be so shaped if possible as to leave no thin margins to the porcelain. A thin margin usually means a fractured margin in a short time. With cavities for gold inlays the exact opposite is true. One of the chief virtues of gold inlays is that the enamel margins may be freely beveled and the gold allowed to lap over them—a relatively thin layer of melted gold being sufficiently strong for ample protection to the enamel. It is with this idea in mind that the following detail of cavity formation for the different classes is suggested.

Cavities in the labial surfaces of incisors and cuspids, and the buccal surfaces of bicuspids and molars. The first essential in the preparation of these cavities is to open the cavity freely by breaking down all enamel undermined by decay. The axial or pulpal wall should be made perfectly flat so that the inlay will have a definite seat to rest upon. This is conveniently done with an inverted cone bur stood with its end looking toward this wall, and carried laterally across the floor of the cavity. There should be an angle formed between the axial wall and the surrounding walls, not a perfectly right angle so as to leave the surrounding walls parallel, but very nearly so. If these walls were perfectly parallel it would manifestly be impossible to fit a matrix and remove it, but the nearer they approach to this the more securely will the inlay be anchored, and the less necessity for relying on the cement as an adhesive agent. Cement should be used in the capacity of a sealing material between two joints and not as a glue to hold the inlay to the cavity. In short the cavity should be so formed that there shall be some frictional retention against the surrounding walls, the inlay in many instances going to place with a snap. When cavities are formed along these lines there will be less trouble from inlays dropping out.

It might be imagined that the fitting of a matrix to such a cavity would be very difficult but this is found in practice not to be so, and even if it did slightly complicate this part of the operation it would be justifiable on account of the greater security of the inlay.

There should be no beveling of the enamel margins for porcelain except as the slight divergence of the surrounding walls at the orifice of the cavity forms a bevel. In the use of the inverted cone bur for forming the axial wall if the sharp angle of the bur should undercut the sur-

rounding walls they may be trued up with a chisel or with a fissure bur stood with its end looking toward the axial wall and cutting with the side of the bur. The outline of a cavity formed as just indicated is shown in the two sections of an incisor, Fig. 254, longitudinal, and Fig. 255, cross-section.

In bicuspids the form of the axial wall is sometimes different from this on account of the difference in the form of the tooth. If the axial wall were cut perfectly flat in some cases of extensive decay it might result in exposure of the pulp and so it should be given a convex form as indicated in the cross-section of a bicuspid, Fig. 256. This form facilitates the firm seating of the inlay fully as well as the flat form, and in some instances furnishes a more secure anchorage.

In extensive penetration of caries where the cavity runs under a strong wall of overhanging tooth tissue and it is deemed undesirable to cut this wall entirely away, it may be permissible to excavate the cavity perfectly and fill the undercut with cement. After this has become

Fig. 254.

Fig. 255.

Fig. 256.

Fig. 257.

hard the cavity may be prepared as usual. This practice is not often feasible on account of the fact that ordinarily when decay undermines a wall it does so in such a way as to weaken it beyond the possibility of retaining it with safety.

Upon broad surfaces such as the buccal surfaces of molars we frequently find decay running along over a considerable area with little penetration into the tooth, and in these cases if the cavity is formed on correct mechanical lines with flat seat and proper angles it need not be made very deep. But an inlay for such a cavity should be of strong material and it is usually best in all buccal cavities of molars to insert gold inlays in preference to porcelain.

Simple cavities in the proximal surfaces of incisors and cuspids. These cavities must be opened sufficiently to the labial or lingual to admit of fitting the matrix, and it is therefore necessary to cut away one of these walls quite freely; though the ample separation of the teeth in advance of the operation will in some measure dispense with this necessity. The same provision for seating the inlay firmly in place should be made in these cavities as in others and the axial wall should be made

as flat as possible. If the labial wall has been cut away and the lingual wall remains standing with sufficient integrity to admit of it being left, there should be an angle formed between it and the axial wall, and even where the lingual wall must be removed it will be found possible to make a point angle in the gingivo-linguo-axial region. The gingival wall should be made at nearly right angles with the axial wall and almost parallel with the incisal wall, which should also join the axial wall at an angle, so that the inlay will lock between the incisal and gingival walls as if in a box. Fig. 257 illustrates the labial of an incisor with the marginal outline of the cavity indicated, and the dotted lines showing the interior form of the walls.

In cases where there has been much breaking down of the lingual wall with a strong labial wall standing, the cavity should be opened mostly to the lingual and the inlay inserted from this direction. In these cavities an angle should be made in the gingivo-labio-axial region so as to form a flat seat of resistance at this point, which will receive most of the stress brought to bear upon such an inlay.

Cavities in the proximal surfaces of the anterior teeth involving the incisal angle. These cavities present a more difficult problem for porcelain to meet than any of those where porcelain inlays are indicated, and yet their exposed positions often call for this kind of restoration. It is therefore necessary to study very carefully the forms that shall be given these cavities for the most secure anchorage and the greatest strength to the porcelain. The operator must individualize his cavities and take advantage of every possible opportunity presented by the peculiarities of the case to gain depth to the cavity and bulk to the inlay.

It will usually be found that to gain security of anchorage some form of step must be made in the incisal region, and yet there are certain cases which do not lend themselves readily to this method of treatment. Ordinarily the step is made by cutting across the incisal edge at right angles to the proximal portion of the cavity making approximately an L shape to the inlay, but sometimes it is not expedient to cut away the angle of the enamel in this manner. This is particularly true of those cases where the decay has involved the lingual surface far in advance of the labial in upper incisors leaving little tissue in which to form a step. It is also true in some instances where there has been a simple proximal cavity of shallow depth in either an upper or lower tooth and the incisal angle has fractured off following a check in the enamel leaving a clean sound surface of tissue along the axial wall with the enamel in perfect condition in the incisal region. These are cases which do not call for much incisal exposure to stress and it would seem too radical a procedure to cut away the incisal enamel, besides increasing

the exposure. If the teeth in these cases are well separated a cavity may be prepared by cutting a shoulder in the axial wall looking toward the incisal and about one and one-half millimeters from the incisal edge, as indicated in Fig. 258. This should be supplemented by a rather deep and strong anchorage in the gingival region, and if the teeth are sufficiently separated the inlay may be slipped into place laterally. This form of anchorage is of course not the strongest from a mechanical point of view where great stress is exerted on the inlay, but in a somewhat close observation of many cases in practice it has proved sufficiently satisfactory to recommend its use in the class of cavities indicated.

Where the step anchorage is employed it is usually best to shorten both labial and lingual plates of enamel at least half way across the incisal edge (Fig. 259, labial view), though this is not invariable. Sometimes the labial enamel may be left standing in upper incisors provided

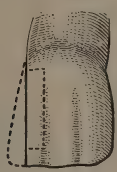

FIG. 258.

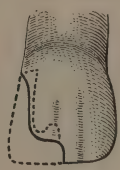

FIG. 259.

FIG. 260.

sufficient bulk can be given the porcelain in the step. In either case the lingual plate should be cut away more than the labial, and this is particularly true near the termination of the step. At this point the lingual aspect of the step should be made to dip rootwise quite perceptibly to provide an interlock to the inlay (Fig. 260, lingual view). Care should be taken that there are no thin edges left to the inlay in any of its outline and this is accomplished by cutting the enamel with little or no bevel. It is also possible in some instances to add to the bulk of the porcelain in upper teeth, and thus increase its strength in the region of the step, by building it fuller lingually than the tooth originally was. The relation of the lower incisors will often admit of this and in some instances it is advisable to slightly shorten the lower tooth to give the needed space.

In the gingival region provision should be made for a broad seating of the inlay. The gingival wall should be flat and as wide mesiodistally and long labio-lingually as the available tooth tissue will permit. No undercutting is of course permissible but the labial and lingual walls may be made to extend from the gingival wall in a very nearly parallel direction. This will give a box-like form to the cavity in this region and result in security to the inlay when cemented.

Cavities for the restoration of incisal tips. It is sometimes found practical where the incisal portion of an anterior tooth has been marred by faulty development, so as to be dwarfed and unsightly, to restore the end with porcelain. It is also possible in some instances to do this where the incisal portion of an incisor has been broken off by a blow, though the cavity preparation for the two is entirely different. In the first instance there is usually a thin projection of tooth tissue standing on the end of the tooth as if the enamel had been stripped from it, and this may be utilized as a tenon over which the inlay may be mortised (Fig. 261, longitudinal section of an incisor mesio-distally, Fig. 262, longitudinal section labio-lingually). The shoulder where the perfect enamel begins and against which the inlay is fitted should be cut at right angles to the tenon, and the latter so trimmed that the matrix may be fitted over it and removed without dragging.

In the case of a fractured tooth leaving the end flat the problem

FIG. 261.

FIG. 262.

FIG. 263.

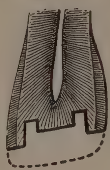

FIG. 264.

FIG. 265.

of anchorage is greatly complicated. Retention must be gained by drilling into the fractured surface and the danger of approaching the pulp is always a factor in the case. If the fracture has not occurred far rootwise a groove may be made running mesio-distally across the tooth (Fig. 263), shallow in the center to avoid the pulp and deeper at each extremity where it passes mesially and distally of the pulp (Fig. 264). If the fracture has extended so near the pulp as to reach a thick part of the tooth so that the labio-lingual width of the fractured surface will permit it, two grooves may be made, one to the labial and one to the lingual of the pulp, and these should join the labio-lingual grooves at either side (Fig. 265). All grooves for this purpose should be made flat at the base and as broad and deep as the tissue will permit.

Cavities involving the proximal and occlusal surfaces of bicuspids and molars. These complex cavities are usually better managed by the use of gold inlays than porcelain and the detail of cavity formation herein suggested is in accordance with this idea. The most serviceable of all inlay work is in connection with the large restorations frequently necessary in these cases, and the operator should study carefully the possibilities of inlays in those positions in the mouth where the difficulty of inserting

large fillings of foil has frequently proved a serious physical and nervous tax on patient and operator.

As has already been intimated the preparation of these cavities involves a wide extension bucco-lingually of the proximal portion of the cavity as it reaches the occlusal, and wherever a step can be made in the occlusal surface at right angles to the proximal the chief reliance for anchorage should be in this step. This is particularly true of bicuspids where the bulk of tissue for anchorage in the proximal region is not so great as in molars. The step should be given a dovetailed or interlocking form so as to avoid any possible tipping of the inlay and this may usually be accomplished in one of two ways, dependent upon the form of the tooth. Where the cusps are prominent and the depressions between them deep it will usually be found that there is an appreciable concavity at the termination of the step most remote from the proximal cavity, and in this instance the step at this point may conveniently be made much wider bucco-lingually

FIG. 266.

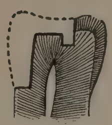

FIG. 267.

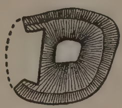

FIG. 268.

FIG. 269.

than it is midway between the cusps. The effect is to dovetail the step portion of the inlay against any possibility of tipping. (Fig. 266.) Where the occlusal surface is more nearly flat with little prominence of the cusps and almost no depression between them, the interlock may be secured by deepening the termination of the step rootwise as shown in Fig. 267, a mesio-distal, longitudinal section of an upper bicuspid.

The same provision for a flat gingival wall in the proximal portion should be made as in incisors, and the buccal and lingual walls should extend from the gingival in nearly a box-like form. If the cavity is prepared in this way and the inlay properly fitted it will snap into place with a frictional retention against the walls which adds greatly to the sense of security. Such an inlay will not rock or tip on pressure even before it has been cemented.

In case the enamel on the occlusal surface leading from the cavity is perfect and it is deemed not advisable to cut into it to form a step, retention against tipping may be secured by making the cavity slightly wider bucco-lingually at the axial wall than it is at the dento-enamel junction (Fig. 268, cross-section of a lower molar). This forms a dovetail and in cases where there is sufficient bulk of tooth tissue to work on

it may be done without weakening the walls. It is of course apparent that the only direction in which a model or inlay can be removed from such a cavity is toward the occlusal surface.

In other cases where the dentin is so involved in the occlusal region as to leave the axial wall greatly concave and no foundation for a step, an interlock may be gained by shortening one of the cusps and building the inlay over it (Fig. 269, lingual surface of a bicuspid). It will be found in these cases that the dentin is quite extensively dissolved from under the enamel as it arches over the cusp and the wall is made more secure by cutting down the cusp and protecting it with gold. This may be done with both cusps if necessary where there has been much undermining of the enamel, and even this extensive restoration may frequently be necessary without the pulp being involved. These are the cases which heretofore have been quite generally consigned to crowning, but an inlay restoration such as just indicated where even the entire occlusal surface is reproduced in gold is in every respect preferable to a crown. And this is not only true of these cases but of others still more extensive where the mesial, occlusal, and distal surfaces are involved in the same tooth, requiring a restoration of all three with the gold overlapping the buccal and lingual walls. (Fig. 270, lower molar, buccal surface.)

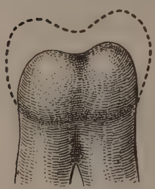

FIG. 270.

The general form of the cavity in such cases must of course be governed by the conditions presented. Weak or overhanging enamel should be ground away quite freely for the double purpose of securing a firm foundation and for thoroughly opening up the cavity. The principle of the flat seat for the inlay to rest upon should be maintained as largely as possible, because of the necessity for security against dislodgement under the severe stress of mastication to which such restorations are subjected. The enamel margins should be beveled away quite freely with the utmost confidence that the gold will form an adequate protection to them.

In case the pulp is dead advantage may be taken of the pulp chamber for anchorage after the canals have been filled, but in the event of this additional anchorage not being required the chamber may be filled with cement and this leveled to form a flat seat for the inlay.

Cavities in the occlusal surfaces of bicuspids and molars. It is a very rare condition which calls for an inlay in the occlusal surface of a bicuspid unless it involves some other surface. A simple occlusal cavity can be more judiciously managed with a filling than an inlay, and it is only in molars with cavities of appreciable extent where it is judicious to make occlusal inlays. The preparation of these cavities is not complicated. The floor or pulpal wall should be made flat so as to be at right angles to the stress of mastication, and the surrounding walls should be nearly

parallel to make a mortised effect to the inlay (Fig. 271, section of a lower molar).

In cases where there has been an extensive involvement of the tissue undermining the occlusal enamel leaving it frail, it may be ground down slightly past the marginal ridge and the entire occlusal surface reproduced in gold (Fig. 272).

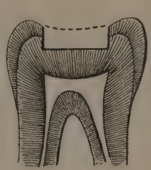

FIG. 271.

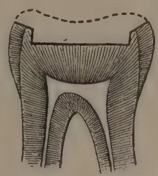

FIG. 272.

The technique of cavity preparation for inlays is quite simple and the operation altogether more acceptable to the patient than for fillings. There is no necessity for applying the rubber dam and this to many is a great relief. The cutting is mostly done with chisels, excavators, and such rotary appliances as stones, wheels and disks. The only necessity for the use of burs in large cavities is in sharpening up some of the line angles, and to flatten the walls left rounding by the stones. The fact that the grinding may be done under moisture reduces the pain to the minimum, and this is a great recommendation for this class of work.

CHAPTER XVI

THE PORCELAIN INLAY

BY W. A. CAPON, D. D. S.

The eventual success of porcelain as a filling for teeth depends upon thorough consideration of two primary principles, viz., foundation and adaptation. The first term applies to cavity preparation, the second to matrix formation, and they are closely allied in importance. The consideration of the former by a preceding chapter allows the matrix to become my first topic.

METHODS

There are two methods of making a matrix called the "direct" and "indirect" and either can be used according to the desire and training of the operator. The indirect method consists of taking an impression of the cavity with modeling compound or a hard wax and making a model of some hard material such as amalgam, cement or low-fusing metal.

There are many adherents of this mode of making an inlay who claim equal results with the older and more popular method of working directly on the natural tooth. It is a debatable point which is best settled by thorough trial by the student. The advantage claimed is that inlays are made by assistants and a series of operations carried at the same time without delay. In the writer's estimation there are disadvantages that more than offset what is claimed, viz:.

A greater cutting of tooth substance to allow an impression material to accurately portray the cavity edges.

The difficulty of reproducing with any material a cavity edge as perfect as the natural tooth enamel. The amount of technique required before a matrix can be made, and finally the passing to a subordinate the artistic and most important part of the operation. However, that may be a motive for many who enthusiastically claim the indirect method as being preferable.

The writer's many years' experience has proven the direct method of taking the matrix to be simpler and more expeditious and therefore presents that procedure in detail as follows:

The metals used for matrices in porcelain inlay work are made of either platinum or gold foil and their respective value for this purpose is

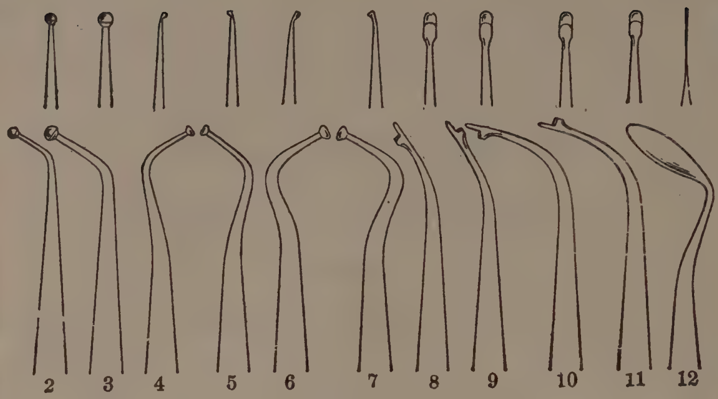

FIG. 273.

usually an argumentative point whenever the subject of high or low fusing porcelain is discussed. Adherents of high fusing porcelain have no choice except platinum while the advocates of lower heat material can use either gold or platinum. Platinum has for its recommendation adaptability and stability of form, together with its great resistance to high heat, thus dispensing with the necessity for an investing material to keep its form. The virtue of gold is its ductility and easy adaptability to floor and walls of cavity, but this very softness in the majority of cases renders an investment necessary, thus precluding any trial fitting or reburnishing which is of so much assistance especially to the beginner. It being my intention to describe the use of high fusing porcelain particularly, I have no alternative of a choice of metals for a matrix even if so desired, and will consider the subject from this point of view.

The difficulties connected with making a matrix are somewhat regulated by the position of the cavity and the amount of working space in its immediate vicinity, therefore it may simplify the subjects to divide them into three grades as follows:

1. Labial and buccal cavities.

2. Proximal cavities in anterior teeth with lingual surface not involved. Gingival cavities curving well to the proximal.

3. Proximal cavities in incisors involving lingual surface, proximo-incisal restorations, distal surface of cuspids, mesial surface of first and second bicuspid and first molar.

Sufficient space between teeth is imperative with this class of operations because porcelain is unyielding and cannot be forced to position without

risk of chipping edges. The matrix must come from the cavity without change of form and frequently there is plenty of space for the inlay when finished, but owing to necessary excess of matrix material it locks itself when there is apparently sufficient space. The impression of the cavity or matrix is made with gold foil No. 40 or pure platinum gauge $1/1000$ in. or .001 in. thickness—thoroughly annealed. In these days of inlay requisites this material is kept ready for use by all dental dealers, but it should not be handled much before using and it should be *pure*. If greater softness is required give it a high heat in the furnace muffle. I emphasize the word pure because iridium and platinum are naturally alloyed and as iridium is the most difficult metal of the platinum group to eliminate, this fact may account for the variance in softness in different purchases. The proper thickness of the metal has been a point of considerable discussion, but it is now generally conceded that $1/1000$ is the correct thickness for most operations. It may sometimes be slightly heavier, but never thinner. Many argue that if $1/1000$ is good $1/2000$ must be better because of the minimum amount of metal at the edges, forgetting or not knowing that burnishing reduces thickness to a lighter gauge.

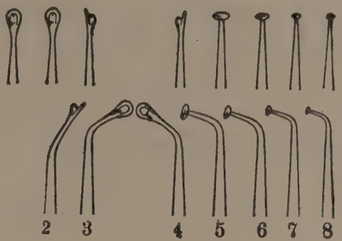

FIG. 274.

Labial cavities in central incisors are in the first grade, therefore a detailed description will be more easily understood.

The foil is cut sufficiently large to allow holding against adjoining teeth, and somewhat diamond shaped, the extreme ends being held firmly by the first and second fingers of the left hand, leaving the right hand free to use the instruments for burnishing.

My preference is for few and simple instruments such as two or three sizes of rubber tips and some amalgam burnishers.

Special instruments such as those designed by Dr. W. T. Reeves, and Dr. C. N. Thompson have extensive use and fulfill the requirements desired. (Figs. 273 and 274.) Dr. Jenkins presents new burnishers made of glass. It is claimed that the metal is forced to position with less danger of tearing because of the absolute smoothness of contact surface.

Whenever possible it is well to give the outline of the cavity by the rubber points or spunk held by ball tipped pliers pressed firmly over the cavity, stretching the metal with safety, then rotating a ball pointed instrument with gentle pressure, commencing with a large size, following with smaller ones until the metal is fairly well adjusted; then use small

pieces of spunk, chamois skin or camphor, packing tightly. It is now safe to use the other hand and with it hold the matrix in place with a blunt instrument pressing the packing, then burnish edges thoroughly, but not roughly for fear of tearing. A break on the cavity edge means a new mold while one at the bottom of the matrix is of no moment. Remove spunk or whatever has been used as an assistant and carefully release the matrix which is now ready for the porcelain. If inadvertently there is an undercut in the cavity sufficient to lock the matrix, gently force it out, then replace and reburnish the edges, not touching the interior, thereby making a change of the cavity unnecessary.

The making of a matrix for a proximal cavity requires more skill and practice. The foil should be carried well above the gingival margin of the cavity and if the gum is even with it the edge of the metal should be turned to look toward the proximating tooth and lie over the gum, giving a sure working surplus. Rubber points are not much used in these places, therefore take the flat end of the burnisher and press across the cavity edges gently, forcing the foil to position assisted by small squares of spunk. The burnishing and general procedure is the same as for a simpler cavity except that usually surplus foil is in the way if both labial and lingual surfaces are burnished flat to the tooth, therefore if drawing from the labial side, have the lingual surface approximately burnished, take out and cut surplus off, then replace and get outline more perfectly and thus save a probable twisting of the matrix caused by an excess of material. If the cavity has greater presentation toward lingual surface the same rule is applied. Many practitioners suggest that much assistance can be gained by holding matrix in place with rubber dam, gold beater's skin, or china silk, and burnishing the matrix through these materials.

Some years ago Dr. Allen, of Kansas City, added gum-camphor to our equipment as an assistant in making a matrix and it is most excellent when used properly, but many operators make the mistake of using it everywhere, forcing it in the cavity when the matrix is unprepared, and the result is an aperture from edge to edge therefore it is well to have the cavity walls fairly outlined before using it. It is of most value in labial cavities or where there is plenty of space to permit of easy withdrawal. After the matrix is made it is recommended that it be thoroughly cleansed by placing it in alcohol which will cleanse it of saliva or blood if camphor packed. The action of alcohol will dissolve the mass so it will drop out. Passing it through an alcohol flame will burn it out leaving no residue which is one of the recommendations for using this material for packing; however, if gold is being used it is safer to use alcohol alone. After the matrix is cleansed clasp the surplus portion firmly with a pair of straight fine pointed tweezers and fill the mold with the shade of porcelain chosen,

which is mixed with clean water or alcohol or a mixture of both and applied with a fine pointed sable pencil brush and the little lump of stiff porcelain is gently patted or jarred to place. The edges of the cavity form are traced clean with point of brush and the embryo inlay is laid face down on absorbent paper or a clean napkin which abstracts the surplus moisture. Dusting dry porcelain over the moist surface is also recommended. I prefer applying the first piece so dry that it is difficult to pick up with the brush. It is at this point that the advantage of a sable brush is noticed because it holds a point without drooping while camel's hair droops and has no stability.

If the matrix should have a pierced or broken bottom which is almost unavoidable in a deep cavity, fill it as if it were intact and unless the aperture is extremely large it is surprising how much tapping or forcing is required to make the porcelain pass through; however under all circumstances it is a safe rule to turn the matrix bottom side up and examine it closely and trace it with a clean brush, otherwise a very small particle of porcelain left unnoticed and becoming fused will make the work to this point useless.

If a break is made on the cavity edge of the matrix, condemn it and make another, as it is impossible to have a perfect margin unless the matrix is intact on that margin.

When excess of moisture has been removed, place it on a metal or fire clay tray at the mouth of the furnace, gradually pushing it to the interior, using care that too quick evaporation does not loosen porcelain from walls of the matrix. If this occurs a refilling of the mold is the only alternative. Close the door of furnace and the process of fusing has commenced. The shrinkage of porcelain plays a prominent part in all such operations and unfortunately it keeps the most experienced "guessing," therefore those unfamiliar with the work are handicapped at the beginning by a difficulty that must be reckoned with always. In fact a student's first lesson is the showing of an artificial tooth before fusing and after, and it never fails to create surprise and comment and is a simple object lesson that impresses. Shrinkage of porcelain is always a fifth of its bulk, sometimes quite one-fourth. In small matrices it cannot make much change, but in proportion to the size and quantity do the difficulties increase. It may draw from the walls of the matrix and form crevices at those parts, or it may shrink and draw the form with it, and to avoid this my favorite way is to mix small particles of broken porcelain with the paste. Another way is to cut grooves or concaves at its greatest bulk which divides the material and avoids the crevicing to some extent. The main desire is to have a shrinkage that will change the form of the matrix the least, and some porcelains have a value in this respect. An invested matrix is more

secure, but it has drawbacks that in my estimation are often detrimental. A matrix for investment may be intact at every point which is possible with gold, but not always so with platinum. Once invested it must be completed in that form thus debarring opportunities for trial or reburnish, added to which are the increased difficulties of getting proper form or contour while invested.

FUSING

This is the coherence into a solid mass of the various substances which constitute porcelain and it is this cohesiveness which causes shrinkage, and because of this shrinkage repeated firing is imperative to obtain the necessary bulk of solidified material. It may be twice, three times or more according to the extensiveness of the operation, therefore a knowledge of fusing is an important part of making an inlay, and one that necessitates considerable experience. Of course results are obtained without experience or much practice, but these results are not always properly fused porcelain. To illustrate this point let me state that a certain dealer and manufacturer wishing to impress upon the profession the advantages of a pyrometer attachment molded small pellets of porcelain of equal size and of one color and mailed them to "porcelain workers" in various parts of the country, asking them to fuse and return. I was so favored with this request, but did not know the results for some months afterwards when by chance I saw the "returns" mounted on a card for exhibition purposes and the various shades and qualities produced by that one little pellet was a revelation. They were all supposed to be correctly fired and no doubt each participant in this trial thought his specimen a correct one. This shows in a simple manner why there is so much demand for information regarding shading, which demand can be lessened by greater knowledge of fusing. How can this knowledge be obtained in the most practical manner? By studying the various degrees of heat with the eye which may be aided by a watch or a pyrometer, but with either of these or any other guide the correct fusing or baking of porcelain reduces the problem to one of personal equation.

A pellet of gold is recommended by many to assist in determining the fusing points. The gold is placed in the muffle near the inlay and its melting denotes the fact that a certain temperature is reached, and so much time by the watch is allowed between the melting of the gold until the fusing of the porcelain. The time to allow is learned by repeating firings, but various sizes of porcelain being baked at the same time must be guessed at.

The use of a pyrometer in connection with a furnace is accepted by many as being the most scientific solution of our fusing troubles,

and there is no doubt that it is of much assistance to the majority, but it is a machine and therefore it has no judgment and fusing porcelain requires that necessity. Concentration of a thousand heat units for twenty minutes will produce certain results and the same condition will be obtained by increasing the volume and reducing the time, and as we are fusing irregular quantities, either the heat or fusing point must be varied because these fusing points now used as a standard were obtained by baking porcelain pellets of uniform size at a regular heat for a certain time with the rheostat on a positive point. These facts, therefore, must place the pyrometer in the position it should occupy and that it is a guide which will indicate the furnace heat and *not properly tell* when the fusing has taken place. The man who uses his eye as a guide can fuse any material under all circumstances and feel that he has control of the situation, providing he uses an article which fuses at 2300° or less. Over that point it is a greater strain on the eyes and the value of a pyrometer is correspondingly increased, but the proportion of operators using such excessive heat for inlays is very small.

The operator after some practice will observe that various degrees of heat have a shade indicative of the point he desires. The first will be a deep orange color which will fuse a low porcelain body ranging from 1500° F. to 1800° F. If an electric furnace is being used, advancing the rheostat to the next point will increase the brightness of the muffle to a yellow, giving a fusing temperature ranging to 2100°, and another step higher a bright yellow appearance, and a heat sufficient to fuse most of the "high fusing" bodies or those ranging in the neighborhood of 2300°. Beyond this point there is a glare that may be injurious to the eyes unless protected by smoked glasses.

Dr. Hart J. Goslee, in an article on this subject makes a valuable suggestion that I take the liberty of quoting. "A degree of familiarity with the physical change which takes place during vitrification and which will enable one to thus detect the proper fusion, may be easily required by the continued fusing of small cubes of properly mixed 'body' placed upon the labial surface of a central incisor facing until he can distinguish between the granular surface of the 'body' and the glazed surface of the facing and observe when the surface of the former becomes the same as that of the latter."

The "first fusing" is carrying the inlay through these various stages of heat until it arrives at what is usually termed a "biscuit bake." This is a reduction of the different ingredients to a solid vitrified mass without a gloss. Drawing it from the furnace in this condition and exposing it to the air does it no injury, in fact small work even when finished does not

require particular care in this respect; but large sections and crowns should be immediately placed in a cooling muffle until cool enough to handle.

After the first bake the surplus platinum is trimmed and the inlay adjusted in the cavity. The removal of excess matrix material insures easier access to its position and allows a better observance of general contour. The flat blade of a burnisher is pressed along the edges until the matrix sets firmly in position and that part of the matrix which may have been changed by the shrinkage is forced back to the cavity walls. The inlay is again removed and body added, first cleaning off the surface with a brush, being careful to have any crevice thoroughly filled with porcelain, thereby preventing little air holes which sometimes defy considerable tapping. Reburnishing the inlay will soil the surface to some extent and it may also come in contact with saliva or blood, therefore dip it in alcohol, and place at mouth of furnace until the impurities are destroyed by heat, thus insuring a positively clean surface and unalloyed porcelain. The inlay is again given the same considerations as at first baking, but watched with greater care when the heat is nearing the fusing point, because insufficiency of heat will not produce the true shade or finished surface, while too much heat will make it lighter in proportion to the excessive heat beyond the exact point, and reduce the quality of the material.

Better results will be obtained by withdrawing the inlay before it is thoroughly fused and note the condition particularly in regard to amount of material, for if another layer of prcoelain is required to give it the proper contour or to have the inlay level with the margins of the matrix, it is better to make this addition at this time, and in so doing the whole mass will be more homogeneous with a truer shade if the final heat is correctly gauged.

If the inlay is satisfactory to the operator the next step is to strip the matrix, which is done with fine straight pointed tweezers, catching the outer edge and turning backwards toward the middle which will avoid chipping the edges. Very frequently small pieces of the metal adhere very persistently to sections of the porcelain. These may not be of disadvantage in large inlays, but in small ones the shade might be affected, therefore it is recommended that every portion be removed, and an old bur will do this easily. My usual procedure after stripping the matrix is to place the inlay in the cavity, always wet, which brings out the shade and adds life to it, and it is at this point the new porcelain worker has his first desire for a transparent cement. It is now that the patient is invited to view it for he is usually as interested as the dentist, and it is also good policy to explain the probable change that will take place by the drying of the tooth and the cementation. This

change is often temporary though sometimes permanent, much to our disappointment, but experience may help to reduce it to the minimum.

The inlay must now be prepared for retention. There are three important factors toward permanency, first, shape, which is given by due consideration of cavity preparation, second, the undercutting or serration of the porcelain, and third, the quality of cement. Many failures can be attributed to concentration on the latter, ignoring the importance of the first two requisites. Careful attention should be given to the inlay itself, large or small, thereby saving time, discomfort and reputation. My preference is undercutting or grooving when possible, but that is not always practicable, so it may be necessary to etch the cavity side of the inlay with hydrofluoric acid which has a powerful chemical affinity for all vitrified surfaces, destroying the gloss and allowing a better union with the cement. Almost the same results are obtained by using small carborundum or corundum stones, and many follow this method exclusively, while others use both roughening and grooving.

The disks employed are diamond, hard rubber and corundum or carborundum. The diamond disks are expensive and unless used carefully very soon lose their efficiency. The cheaper disks cut quickly and with moderate care are durable. An objection to carborundum is its brittleness, and the fine black dust that lodges in the porcelain and is not always easy to eradicate. The groove should be made on at least two sides and more if possible. In using acid care must be taken to keep the finished surface intact and this is done by making a block of beeswax about one inch square, soften a surface over a flame and sink the inlay face down using a warm spatula to cover edges. Drop a little acid on the exposed surface and leave it for five to eight minutes, wash off with water and put the inlay in alcohol which will loosen a fine scale which is scraped off with an excavator. If this surface is not removed the cement will not get a true attachment. No matter how the inlay is prepared it should be thoroughly cleaned with alcohol. The mouth is now put in readiness for the final adjustment of the inlay. Thorough dryness is an important essential, and for this purpose probably the rubber dam is the most efficacious, although if one is accustomed to the proper use of napkins, the unpleasantness of the dam can be avoided in the majority of cases. The cement is mixed to a creamy consistency and applied to the cavity with a spatula and the inlay inserted immediately, forcing it to position by gentle pressure, holding it there until crystallization has commenced. If the inlay is of a simple character further directions are unnecessary, but if complex and extending to the incisal or occlusal surface material assistance is obtained by a soft wooden wedge such as a

tooth pick, or waxed floss silk wound about the tooth. A tape floss silk or cotton strip is advantageous because the broader surface equalizes the pressure and as it is drawn over the joints it removes excess cement and exposes the union, showing at a glance if the porcelain has its correct position. When it is not convenient to do this the use of small squares of spunk, which is soft and firm, for the removal of excess cement while it is soft has a distinct advantage.

After the cement has set and before removal of dam or napkin cover the operation with some moisture preventative such as sandarac or rubber varnish, chloro-percha or paraffin wax. The last mentioned is preferable because it is not disfiguring and gives a blending effect to the porcelain and tooth and will remain a sufficient time for the purpose desired. The inlay may be finished in an hour or at some future sitting for there is always some finishing with the most perfect work. It may be only a slight disking or it may be that edges need a stone. If so use a small narrow edge of fine grit, grinding no more off the glossed surface than positively necessary, although at times the occlusion is such that the surface must be defaced. After grinding, the surface should be polished, smoothness being the main object.

PORCELAIN SECTION ATTACHMENT

When it is possible to use an all-porcelain anchorage in restoring a section of a tooth, that method is preferable, because the whole mass of


FIG. 275.


FIG. 276.


FIG. 277.

material is of one substance, thereby rendering greater resistance to leverage; but occasionally we must resort to other means of retention, and the use of platinum wire pins, loops, or staples is recommended.

Pins from old porcelain teeth can be used without any other preparation, but they are too thick and rarely indicated in preference to the loop or staple, the latter being adapted to almost every purpose and being also easier to manipulate. Directions for their use are few and easily followed. The tooth is prepared as directed on previous pages, and a platinum matrix made of the edges and cavity, the thickness the same as in other inlay work excepting for the cross-section of a tooth, when it can be slightly heavier. The wire being the anchorage, it is unnecessary to cover the floor of the cavity with platinum, therefore breaking the matrix is expected. This being done, take iridio-platinum wire gauge 24 and bend in staple form to fit.

Figs. 275 and 276 give the idea of wire formation for a majority of cases, while that shown in Fig. 277 is probably more desirable where there

is extreme sensitiveness, it being easier to place retention holes for wire ends than to cut across the tooth to accommodate the loop. The staple with points in the porcelain is stronger, however, than that with the points in the tooth. The attachment to the tooth may be equal in strength, but the tip or corner or any section of the porcelain having the least foreign material must be the stronger, hence the argument in favor of an all-porcelain attachment when that is possible. The weak points of the porcelain shown in Fig. 278 are opposite to the end of the wire, while the weak point of that shown in Fig. 279 is as far as the loop extends, although this weakness will be less in proportion to thickness of the porcelain.


FIG. 278.


FIG. 279.


FIG. 280.

While the matrix is in position, the wire is inserted and held there with paste porcelain made of water and gum tragacanth or mixing fluid. Absorb moisture with bibulous paper or spunk and then gently withdraw the combination from the tooth, and after carefully drying at the mouth of the furnace fuse it the same as other work.

These few simple directions will save the time and trouble necessary for soldering the staple and matrix together, and will also insure a purity of porcelain not otherwise possible.

Fig. 280 shows the loops or pins attached in the porcelain and ready for trial, reburnishing the edges and finishing as represented by Figs. 280 to 284.


FIG. 281.


FIG. 282.


FIG. 283.


FIG. 284.

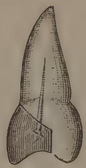
FIG. 285.

Fig. 285 is a part section of a bicuspid showing a way of restoring that is most satisfactory. I have made many such cases, and have yet to learn of the first failure. A whole crown is no doubt quite as easy, to make, but at times a demand for the least loss of tooth makes such a repair desirable.

The building of tips and corners can be more quickly accomplished by using pieces of broken porcelain tooth in the foundation, thus allowing a high heat without change in the prominent contour.

Some years ago a firm in London introduced small wedges of porcelain called "Mellersh Cores," their name being taken from that of the inventor. They are in various shades and will take a high heat without change of form or color, and can therefore be used to advantage in contour work.

CEMENT

It is generally conceded by porcelain operators that while a material of this kind is almost an ideal filling, it falls short of the ideal because we are forced to use as an attachment a substance detrimental to the aim which we have in view, namely, the absolutely invisible restoration of tooth form. Though approximating the ideal we can never fully reach it while we have to depend upon an opaque substance as a means of retention. Still the many good qualities of cement will insure its use for many years to come, for even if an ideal cement should be discovered it will take time to establish a confidence equal to what we now have in the material at present in use. The question may arise as to what is an ideal cement. In many cases what we are now using is ideal, that is from a tooth saving viewpoint, but its failure is that it does not save itself. Cement saves the tooth and porcelain protects the cement, thus making a combination which but for esthetic reasons would be almost perfect. Translucency and perfect color matter little in some instances, but in others they are highly important and the profession should hail the advent of a material having all the necessary qualities as the fruition of a long desire.

Porcelain inlays can be made perfect in shade and shape and the texture may approximate tooth substance in a highly satisfactory manner, but immediately upon attaching it permanently the shade is changed through the difference between the three substances, all of different density, coming in close contact, namely, porcelain, cement, and tooth. The cement being the chief point of difficulty, it is important that the objectionable features should be reduced to the minimum.

It is a poor cement that is not at least a preventative. Many resemble each other in manipulative qualities with the difference of slow, medium and quick setting tendencies. Some are coarse and others are fine and a few have a combination of many good qualities, but with that tendency to "pack" under pressure which causes annoyance to porcelain workers. A cement closely ground of clear color and medium to slow setting, having the maximum adhesiveness with the least amount of powder is what is recommended for a successful operation. In addition to this, it should have the greatest amount of resistance to moisture during what is usually called the "setting" period.

Shading a cement to match the tooth, or to lighten or darken either the porcelain or tooth or both is quite troublesome, and, at times, disappointing. It is of considerable assistance to mix pellets of cement of various shades and mount them on a card. This allows of comparison and saves much time and guesswork. Yellows are the most required, and this is fortunate because pure calcined oxid of zinc is yellow, ranging in

degree of shade from a canary color to cream white, and its chemical combination with phosphoric acid is more complete than when otherwise changed. The variations in shade depend upon the product and it is conceded that the best quality of zinc oxid comes from France. This is of the lightest shade, but it is not safe to assume that the light shades are all of this origin, because manufacturers sometimes produce these variations by coloring matter which has a deteriorating tendency. It may be infinitesimal in blues and grays, but white is made so by oxids of aluminum or zinc which reduce the chemical union of the powder and acid in a marked degree. All phosphate of zinc cements are similar in manufacture and much the same results are obtained, although some are better adapted than others to use in connection with inlays.

Some inlay troubles are caused by injudicious selection of cements, that is using a quick setting cement instead of a slow one, or vice versa. Another factor is improper mixing in the way of insufficient spatulating which gives poor results through non-incorporation of the two ingredients. Cement mixed too thin will not have the body of material required for resistance, with the added danger of displacement during the longer period which it takes for setting. Cement mixed too thick prevents proper seating of the porcelain and a close union, with probability of fractured edges through endeavors to force it to place. Quick setting cements should be avoided in complicated conditions. Slow setting cement has less value on corners and tips, for usually such places have free access and a quicker setting cement will reduce the possibility of displacement, which is increased through prominence.

In past years much attention has been given to the silicate cements which are on the market under various names with many impossible recommendations, therefore a word on this point may be of some interest particularly in connection with porcelain inlays.

SILICATE CEMENT ATTACHMENT

Porcelain inlay operators have noted from the first production of this material that its use instead of oxyphosphate for inlay attachment made an ideal medium, practically obliterating the line of connection. The author with many others felt that the long desired cement had arrived and used it extensively. It was found as time advanced that in a few months the adhesiveness to tooth structure was very limited, but its attachment to porcelain was much greater than oxyphosphate. Naturally the dream of perfection was shattered to be replaced by doubt and condemnation. In recent years there is a marked improvement in the manufacture of silicate cement both in adhesiveness and permanency of shades. The advancement has once again given hope to porcelain workers, therefore

after years of testing all sorts of silicates both domestic and foreign manufacturers under every condition and in every part of the mouth I can safely make the following statements:

Porcelain inlays attached with a silicate cement are particularly desired for anterior operations because there is practically no line of demarkation when the work is first completed, whereas the use of oxyphosphate cement as a rule shows a decided line and detracts from its esthetic requirement. However in the course of a few weeks there is much improvement and later it is quite acceptable if the shade is correct. As the years advance the porcelain and tooth blend to a remarkable degree and the attachment has not decreased, and the cavity walls are thoroughly protected by this cement's remarkable affinity for the tooth substance.

Silicate attachment does not improve with time, but rather the reverse, and it will not be at all permanent unless the cavity is undercut which is not always possible, particularly on incisive edges and proximo-incisal restorations. The border of the cavity wall frequently shows a darker condition due to the lack of attachment and as time advances this increases to an undesirable extent, sometimes appearing as if decay had taken place. This condition is never apparent with an oxyphosphate cement filling or porcelain inlays. The use of porcelain inlays in bicuspids and molars has been much reduced with the advent of cast inlays, but porcelain must be used in certain positions and is frequently demanded by the patient. The disadvantage of its use has been the wearing of the cement line so that porcelain edges became exposed and broke from force of contact. Silicate cement can be used to advantage in such instances because it has more resistance to the action of the oral fluids, therefore the enamel edges are better protected, keeping the whole operation in better form and appearance provided the cavity is undercut for retention.

This possibility is much more favorable on these teeth as compared to those in the anterior section.

SHADING

The color problem in connection with inlay work is one of much inquiry and discussion. It is a phase of the work most perplexing and the rules given by some authorities are both diversified and difficult, requiring close attention even by the most experienced and often proving discouraging to the beginner. The size and position of an inlay will govern shade to such an extent that consideration of this fact is one of the first rules. The application of the shade guide to the tooth may lead to an incorrect conclusion, because quantity of material adds depth to the shade and most of the guides are pointed. Frequently the point is placed against the tooth without allowing the eye to take in the whole size and general

effect. Thus when the inlay is finished it is found to have a lighter appearance which is an error not readily rectified. Overfusing is probably the cause of more poorly shaded inlays than wrong choosing of shade, therefore the choice of something slightly darker is recommended particularly if the operator has limited experience. A rule which can be applied more frequently to a simple labial inlay is to choose a shade darker and reverse the order when applied to small proximal cases. Something darker between the teeth will surely cause a shadow which can be avoided by lighter shades. The cement which is the background is an opaque substance and is therefore a strong factor and one that must not be overlooked, but even with this consideration in mind the most beautifully shaded work is sometimes disappointing. In many cases, however, this is corrected to some extent by time.

In larger inlays and sections of porcelain the cement interference is reduced by being overcome with volume of material and stronger basal shade body which is toned to the desired shade by lighter tints.

Various degrees of yellow are used as foundation shades in the majority of cases with the possible exception of pulpless teeth. These teeth having decreased translucency the opacity of a solid mass is not so noticeable and the question devolves to one of matching alone. And yet the shading of such a tooth requires considerable artistic skill because the operator must do the blending to suit the various shade conditions present and which are not to be found on any one shade guide.

Take, for instance, a large incisal contour embracing one-fourth of the tooth with pulp alive, and the shades may vary from a deep yellow near the gum to a light yellowish-blue at the incisal. This would be matched up with three shades, which are all listed and ready for the mixing; but if pulpless the neck portion might be a brown with a greenish-blue center and a lighter hue at the edge, thus showing that considerable mixing must be done which means guesswork in many cases. The artistic porcelain manipulator is handicapped when compared with a painter who has his palette and colors and desires certain difficult combinations to portray what he sees or is in his mind's eye. He mixes and sees immediate results, whereas with porcelain the shades are powders with no color guidance until the mass is reduced to a vitreous substance, and then not correctly so unless the artistic sense is carried to a completion. A great quantity of matter has been written and published in regard to the proper way to shade porcelain and many excellent rules are formulated, which if they could be carried to a successful issue at all times would reduce this problem to perfection, but rules and directions are of little value without artistic skill to carry them out. This cannot be bought although it may be acquired to some extent, and yet it must be inate in the same

ratio that mechanics are part and parcel of the successful dentist. Rules may assist but they cannot always be practical. It is claimed that the most successful mode of shading is to build the inlay by layers of different enamel shades which "break up the absorption and refraction of light rays," thereby giving an opalescence to the inlay not to be obtained otherwise. This is excellent practice and cannot be criticised when circumstances favor this procedure, but there are times when the blending of shades will give equal if not better results and the simplicity of blending is much easier grasped by the inexperienced. Outside of this is the fact that with one exception all inlay materials are made for blending and the thousands of beautifully matched inlays made with these materials must prove the fact that merit is not limited to the layer method alone.

Dr. W. T. Reeves originated this method and to him we owe much valuable literature on this subject, therefore it will be of interest to reprint what is claimed by him can be accomplished by observing these three rules.

"First. A neutral translucent-looking inlay. Put colors on strong enough, that when covered with what might be called an enamel layer will allow the colors to reflect through, the enamel layer modifying and harmonizing the colors. This will give the translucent effect so desirable.

"Second. If built of three or more layers of different bodies it will break up the absorption and refraction of light rays, so that from whatever angle or point of view looked at it, it will appear practically the same. An inlay built all of one body or mixture will absorb light only from one direction, and viewed from one point will look all right, but from the opposite point of view will show as differently as black and white. An inlay in layers will come very near imitating nature's method of building up a tooth and by breaking up the direct absorption and refraction of light rays, will come very nearly looking the same from all points of view.

"Third. You overcome that great bugbear of most inlay workers, the cement showing through after the inlay is set. An inlay built up in layers will almost overcome the reflection of the cement through from underneath. You will often hear operators say they had a splendid color before the inlay was set, but after it was set the cement killed it entirely. That was because the inlay was baked all of one body and the cement could reflect through from underneath as easily as the light was absorbed only in one direction from above. The three points I claim for this method are translucency, avoidance of shadow, and prevention of cement reflection from underneath."

PORCELAIN BODIES

Until recent years the advancement of porcelain operations was much retarded because of few and unsuitable materials, but now the variety is all that is required.

There can be no objection to every porcelain operator having a varied stock of porcelain, provided his experience has been sufficient to enable a skillful discernment of the various qualities of each, and thereby produce gratifying results by eliminating those of lesser merit until he has secured what in his hands will give the best basis for general application, but the beginner is likely to be confused by many different makes.

The value of a product in the eyes of many is the assortment of shades. This of course is natural if the operator has had little experience, but as he becomes more skillful he finds that at least half the number is sufficient because he has learned that a little manipulation of a certain few will give the same results in the majority of cases. This statement will be better appreciated by those who have had to contend with the earlier condition of affairs, when only a few stronger shades were available, and they will also agree that an ideal shade guide could be limited to a dozen and then readily cover all requirements. The porcelain inlay worker of twenty-five years ago, had much to contend with and many discouragements to overcome, and much of the antipathy to this new branch of dentistry was no doubt caused by the crude appearance of many so-called finished operations, some of which were far from esthetic whilst those having that recommendation were cases fortunate enough to be within the range of two or three varieties of continuous gum bodies such as Allen's, Tee's and Close's. These gave a few shades of yellows which were regulated to a great extent by heat, therefore a tooth with gray or blue tints to be matched up with yellow meant a discrepancy of shade which justified much criticism. Subsequent events have proven that these efforts had merits because they resulted in different manufacturers putting various porcelain bodies on the market, with a larger number of shades and varying degrees of fusing point.

Porcelain work was increasing rapidly in the latter part of the nineties and in 1898 received a gratifying impetus by the introduction of Dr. Jenkins' low fusing enamels with an outfit particularly designed for using this material with a gold matrix, for up to this time platinum was used exclusively for that purpose. The advent of these goods and the process of using them was the origin of the controversy still existing in regard to the superior virtues of low fusing porcelain over the older and longer tried high fusing. This question has been debated

in public scores of times and it is still unsettled, although the differences of opinions are not so positive, for adherents of both factions are forced to admit that each have certain advantages, which when properly recognized lead to the ultimate gain of the work. The introduction of Brewsters' material was an advanced step for the cause of high fusing porcelain and he was the first and only one to give us enamels with basal shades, thereby increasing the possibilities of translucency which was lacking in many products. The writer understands that Brewster's goods are no longer on the market.

The S. S. White Dental Co. have done much toward the advancement of porcelain, having introduced a variety of shades at various fusing points. H. D. Justi & Son have also a splendid assortment with a fusing point sufficient to satisfy the most enthusiastic advocate of high temperature. Johnson and Lund's goods are of the best quality and the fusing point is also high. It is generally conceded that a fusing point of 2200° or 2300° is sufficiently high and quite suited to inlay purposes and the increased strain on the electric muffle and the extra time required for such heat counterbalanced the small advantage of an extreme heat if such exists. The following goods having been thoroughly tested can be considered of a standard quality and the assortment is varied enough to suit any demand.

Whiteley's 19 shades fusing about	2300°
S. S. White Dental Co., 26 shades fusing about	2300°
Johnson and Lund, 25 shades	2550°
Ash and Son, 7 shades	1900°
H. D. Justi & Son	2500°

FURNACES

Porcelain as applied to dentistry at the present time has assumed such importance that it is difficult to conceive of the fact that only twenty years has elapsed since the invention of the first furnace which reduced the time of fusing small pieces of porcelain to a matter of a few minutes, and to this fact we owe the real birth of that branch of dentistry which is generally conceded to be a distinct advancement. There is no doubt that tooth carvers and continuous gum workers of many years back have had visions of what the present generation enjoys by the adaptation of this esthetic work, and they have given much thought toward the solution of the fusing problem, for that was the obstacle first to be overcome, having recognized the futility of much advancement while harnessed to the cumbersome and slow coke furnace.

The quality of workmanship produced in this manner is beyond our criticism which proves that improvements in that direction were not

required, but toward reduction of time and convenience so that small work could be possible and with little preparation.

To Dr. C. H. Land, of Detroit, belongs the honor of being the inventor of the first small furnace distinctly different from any other and especially adapted for this work, in which he takes such an important position in its history. Much praise must be accorded him for his persistent efforts and inventive genius.

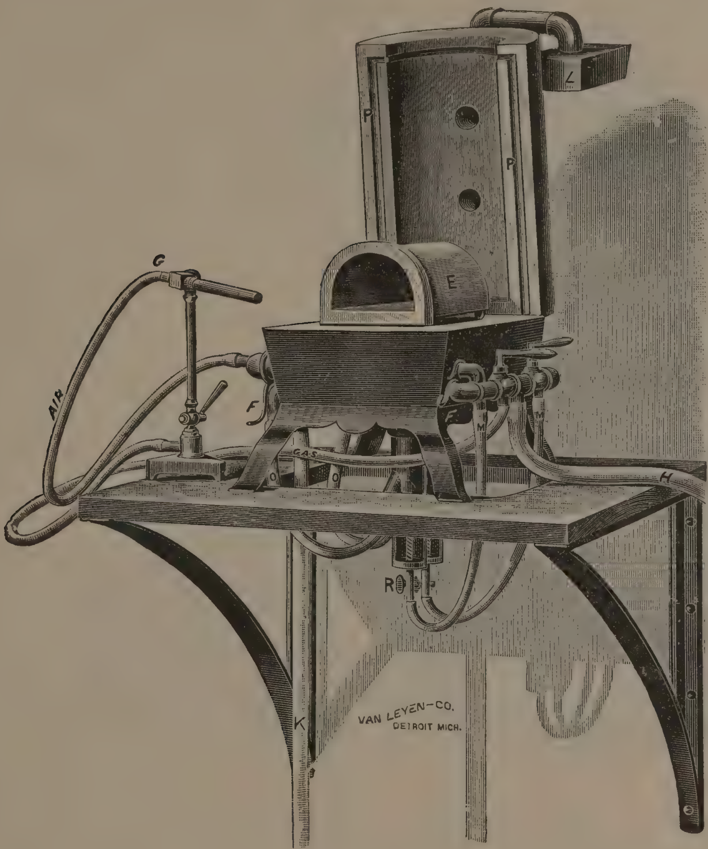

FIG. 286.

This furnace was called a "Compound Gas or Gasoline Furnace" and was first described to the dental public in *Items of Interest*, Oct., 1886, under the heading "Are Hydro-carbon or Gas Furnaces a Success?" (Fig. 286.)

These furnaces were lined with fire clay with a muffle of the same material. The air blast was supplied by a foot bellows and took about thirty minutes' continuous pumping to secure the necessary heat. The results were not always satisfactory, as frequently the gas was forced through the

muffle causing "gassing" which was a difficulty to be contended with in using any gas furnace.

Four years later the same inventor produced a smaller furnace of the same kind which was called "The Midget Blast Furnace" and was a decided advance because the muffle was much smaller and made of platinum, thus allowing quicker heating and reducing the "gassing," tendency (see Fig. 287). These little furnaces could be heated sufficiently to fuse the highest grade material in seven to ten minutes and have been a decided favorite over all others of the same kind, and there are many still in use at the present time. In fact, the writer did not discard his until long after the advance of electricity in this connection, because its efficiency was in marked contrast to the troubles of the more modern electric. These troubles have been reduced considerably, but entire elimination must not be expected.

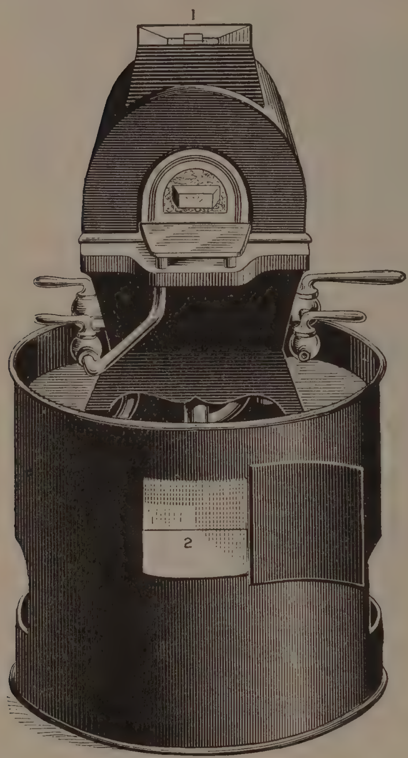

Fig. 287.

In the early nineties several gas furnaces were marketed, the most notable ones being Parker-Stoddart, Fletcher, and Downie.

The application of electricity to dental appliances became general in the early nineties and when Dr. L. E. Custer invented the first practical electric furnace in 1894 the improvement was considered to be a marked advancement, because heretofore the fusing of porcelain by means of gas meant labor to produce the blast which with its attendant noise was most undesirable. Electricity eliminated the possibility of "gassing" the porcelain, a trouble which cannot be understood unless experienced and one which added much to the discouragement of the early porcelain workers. This new furnace being absolutely noiseless and clean was an addition to the operating room and thereby a convenience much appreciated. Its form was adapted more to the use of continuous gum work and is shown in Fig. 288.

It is practically unchanged at the present time, the only improvement being in the heat regulation and easier repair necessitated by wires "burning out." In fact the trend of improvement in all dental furnaces from this date forward has been mainly toward the reduction of this trouble.

Two years after this first electric furnace, or in 1896, the Detroit Dental Mfg. Co. marketed the "Downie" which differed from the former mainly in general form of the furnace and the mode of wiring the muffle.

The next furnace brought to our attention was a very small one invented by Dr. Mitchell, of London, and intended for low fusing bodies as it was practically useless for anything higher than Ash and Son low fusing porcelain. In 1899 and 1900 there were three more, viz., Hammond, Peck and Gerhardt, then the Pelton in 1902 and Price's in 1903.

Fig. 288.

The most recent addition to a numerous list is Roach's Automatic and Caulkins' "Revelation" in 1905. The Hammond had a valuable distinction from all others from the fact that in case of wires burning a new muffle could be substituted immediately. This improvement was a decided advantage and other manufacturers soon made the same arrangement. The Hammond is now substituted by a newer design made by the S. S. White Dental Mfg. Co. The Price was introduced to the profession with a pyrometer attached, and this improvement has resulted in all the leading furnace manufacturers at the present time having a pyrometer attachment in some form or other. There is very little difference in the

merit of these various furnaces, therefore the intending purchaser cannot be far astray in a choice of any one mentioned, although it is important to consider the amount of heat developed on the first step of the rheostat if the dentist is using low fusing material, as several furnaces develop a heat at that point great enough to destroy that material unless watched very intently.

For many years porcelain operations were confined to those fortunate in having electricity or gas conveniences, relegating the practitioner without these advantages to the rear of the vanguard of dental progress. This may not have been a hardship to the majority, because in small places the demand for porcelain work is always limited, but there are many dentists

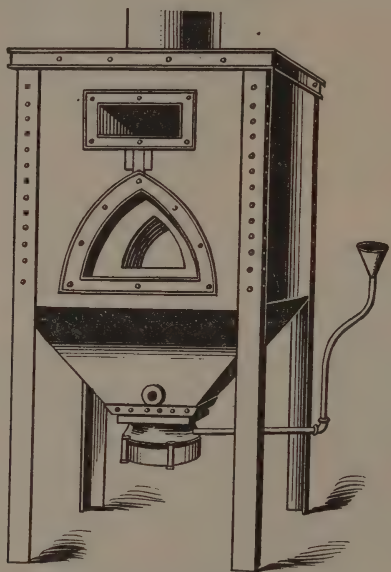

FIG. 289.—Lewellan Furnace.

ambitious to do all kinds of work, therefore the introduction of the gasoline dental furnace by the Turner Brass Works, of Chicago, in 1900, was a decided step toward the advancement and equalization of the profession at large. The furnace is simple of construction and capable of producing a heat sufficient to fuse any porcelain and will do it quickly and safely.

This apparatus with the accompanying soldering appliances enables the rural dentist to be an up-to-date practitioner and the numerous sales of this furnace is a testimony that this fact is appreciated.

There is also another gasoline furnace called the Brophy, which is similar in construction and has equal merit with the original. In conclusion it is apropos to state the fact that improvements in appliances for the purpose of fusing small quantities of porcelain quicker was applied

on a larger scale to the manufacturing of teeth with the result that the old fashioned coke ovens are now obsolete, having been replaced with the more modern oil burners, which are quicker, cleaner and save much labor.

They are an improvement and an enlargement of one made for continuous gum by Dr. C. H. Land, in 1892. The simplicity of its form and amount of high heat produced was one of the wonderment to the profession at that time.

The fuel is the regular refined petroleum or "coal oil syphoned to a burner at the base of the furnace, which is so constructed that a natural draught is all sufficient to produce the highest heat required to fuse any porcelain body. They are absolutely without noise or odor and very economical and highly satisfactory in smaller sizes for continuous gum work, but they can only be used where there is a chimney which is necessary for the draught. (Fig. 289.)

To Mr. Lewellan, of Philadelphia, must be credited the improvements of this furnace which has revolutionized the mode of fusing large quantities of porcelain.

CHAPTER XVII

CONSTRUCTION OF GOLD INLAYS

JOHN EGBERT NYMAN, D. D. S.

Recently the construction of gold inlays has been entirely revolutionized. A method has been devised by Dr. W. H. Taggart, of Chicago, which supplants all other methods. Applicable alike to simple and to complicated cavities in any situation, obtaining readily any desired proximal contour and occlusion, and with uniform certainty of absolutely accurate results, it may well be styled "the best" method of gold inlay processes.

It embodies all the factors that are requisite of any method that may be termed "ideal," such as accuracy and permanency of results, comfort of patient and operator, ease of manipulation, economy of time.

It is essentially a method of accurate casting of gold inlays, something heretofore impossible, but now easily accomplished by means of a marvelously ingenious device for the application of gas pressure to molten gold. One of the essential problems in this process of casting inlays, which had to be solved was the obtaining of a mold which should have no joints or crevices about it; this necessitated a model of the inlay desired, that could be dissipated completely without residue, by some means which would not in any way injure the mold.

Dr. Taggart finally succeeded in producing a wax of which a model inlay could be made in the cavity of the tooth, carving it to the desired contour, proximal and occlusal. It was essential that the wax become plastic at a temperature that could be tolerated by the tooth, that it would not shrink or warp in cooling, that when cool it would be so hard that it could be removed without distortion, but would not be so brittle as to crumble under the carving instrument, that it could be vaporized by heat. All these essentials were finally obtained.

Then there was the problem of the mold. Of what should it be composed and how constructed? It was essential that the mold material withstand a temperature of at least 2100° F. or 1170° C. (slightly above the melting point of pure gold) without shrinking, cracking or softening; that it should be finer in texture than any investment material with which

NOTE.—Figs. 291, 292, 293, 294, 295 and 296 have been supplied through the courtesy of "Items of Interest" and are copyrighted by Dr. H. J. Goslee.

we were then familiar; that it must present an absolutely smooth surface in the mold cavity; that it should set sufficiently hard to permit of manipulation without crumbling. This was finally obtained by a combination of silex magnesia and plaster.

These two factors having been obtained, there still remained to be devised some method of forcing the molten gold into the mold so that it would fill the mold to the uttermost corner, a rather difficult problem considering the strong tendency of gold to "spheroid," as it is technically termed, or "ball up" when in a molten or fluid condition.

The genius of Dr. Taggart, which had solved two of the problems, proved fully equal to the third, and at last after months and months of experimenting with nothing to aid him but his own inventive ability, his masterly knowledge of physics and mechanics, and his faith that he would at last succeed, he did succeed in constructing a machine that would accomplish all that was to be accomplished and so complete was his success, that it was absolutely startling to the profession, creating a sensation such as had never before been known.

It is no exaggeration to state that in the history of the profession nothing to equal this process in value has ever been given it.

The method is as follows: The cavity having been prepared, a mass of the special wax (which is dark green in color in order that the slightest overlap on the surface of the tooth may be readily noticed) sufficiently large to more than fill the cavity is softened by immersion for about five minutes in water of a temperature of from 135°–140° F. or 77° C. This softening must be done carefully and the wax must not be manipulated until it is softened through and through. If insufficient heat is used the wax will crack when it is forced into the cavity. If too much heat is used the surface of it will become pasty and will crumble when an attempt is made to carve it. To soften it in or over a flame must never be attempted as the surface will flow and then become pasty while the interior mass remains too hard to be manipulated. Until one becomes familiar with this softening process, it will be best to use a thermometer to determine when the proper heat (140° F.) has been obtained. A very simple and efficient method of softening the wax is as follows: Obtain a thin cork of large diameter which will fit into an ordinary drinking glass and yet project slightly above the edge of it. Thrust three or four large pins through this at a distance of about half an inch from the center. Pieces of wax are forced slightly onto the points of the pins—the glass is filled with water of about 140° F.—the cork is pressed lightly into the glass and the pieces of wax will then be so immersed in the water that the temperature is uniform on all sides and in a few minutes the wax will be softened evenly throughout. There are now available mechanical devices with automatic electrical control for

the uniform softening to any degree of model wax which are of great assistance in wax model construction. While the wax is softening, let the patient hold water as hot as can be tolerated in the mouth in the vicinity of the cavity so that the tooth will not chill the wax too quickly when it is inserted in the cavity.

The mass of wax first softened should be shaped up by the fingers so

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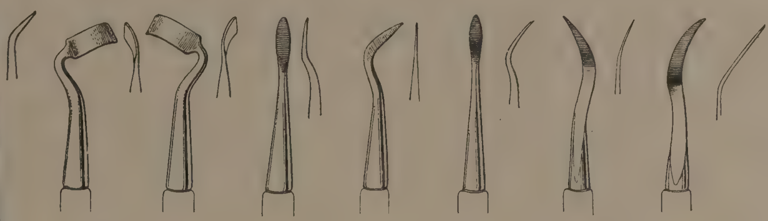


2 3 4 5 6 7 8

FIG. 290.—Instruments for Trimming and Carving Wax Fillings for Gold Inlays. 1. For occlusal surfaces. 2, 3, 4, 5, 6. For proximal surfaces and trimming along buccal and lingual margins. 7, 8. For proximal surfaces, cutting through at contact point and trimming along gingival margins.

that it will approximately fit the cavity, then the partially shaped mass is softened again and pressed into the cavity; this will insure its being forced into every corner of the cavity without cracking.

The wax is inserted into the cavity (which must be moist), pressing it in with the finger tips rather than with an instrument.

The patient is at once instructed to bite into it and to chew upon it. It is then hardened by chilling it with a stream of cold water or having the patient fill his mouth with cold water for a few minutes, then with suitable instruments first carve the occlusal surface to proper contour, carving flush to the marginal edges, leaving no overlap on the surface, the mass which is wedged into the proximal surface holding the filling in place during this operation.

The occlusal surface having been carved, with suitable instruments proceed to carve the proximal surface, holding the wax in place by light pressure with an instrument on the occlusal surface. Do not attempt to carve thick slices off the wax, but simply shave it off with a movement parallel to the margin until at last it is carved flush to the margin with no overlap remaining. The buccal and lingual sections should be carved before proceeding to carve the gingival section, finally passing a very thin instrument through the contact point and slicing off the portion which may have squeezed under the contour of the adjacent tooth. (Instruments suitable for this carving are shown in the accompanying illustration.) Fig. 290.

This method is known as the direct method. Many competent operators obtain splendid results by what is known as the indirect method which consists of taking an impression with modelling compound such as that manufactured by the Detroit Dental Mfg. Co. or the Lochhead Impression Material, manufactured by Lochhead of New York.

A matrix of thin copper or German silver or a cavity impression cup must be used in obtaining the impression. The impression cups devised by Dr. F. E. Roach trimmed and shaped according to the cavity in the case are very useful. This taking of the impression can be done in a remarkably accurate manner provided the operator will train himself in the technique of it, and an accurate impression is absolutely essential to the success of this method. After the impression has been secured, a bite is taken in wax or the softer modelling compounds. The impression is imbedded in plaster, a model is made, with a pyramidal base, of "technique cement" or amalgam (the writer preferring the former). This model when removed from the cavity impression is trimmed if necessary until it can be placed in the proper position in the bite, the pyramidal base is oiled, and articulated models are run in plaster.

The wax model is made in the model cavity and the occlusal surface trimmed to proper shape. Then the cement model is removed form the articulated plaster model and the wax model carved to proper proximal contour. The gold inlay is then constructed after the manner of the direct method. After the inlay has been cast it is replaced in the cement or amalgam model and polished.

This method obviates the difficult carving about the gingival margins of a wax model in the mouth in certain classes of cavities, which carving is often an exacting and anxious process, involving considerable discomfort to the patient. It also obviates much of the finishing and polishing that must be done in the natural tooth if the direct method be used. Furthermore, should a casting happen to be faulty another inlay may be constructed without necessitating another appointment for the patient to secure a second wax model. This method also saves the operator as well as patient considerable time at the chair and if the operator has a laboratory assistant it relieves him of many details.

This method cannot be employed as successfully as the direct method in cavities involving both mesial and distal proximal surfaces as well as the occlusal surface in teeth of marked contour.

The writer employs the indirect method in many cases and, technical and theoretical criticism to the contrary notwithstanding, has seen results in the practices of Drs. Tracy, Gillett and Rhein of New York and Dr. Knowles of Chicago by the indirect method which could not be adversely criticized.

Should the cavity extend rootwise considerably under the gum margin it may be necessary to adjust a matrix to secure an accurate margin at the gingival section, this should also be done in complex cavities including a large buccal or lingual section of the tooth as well as the proximal. In such cases it is well to note the character of the bite before adjusting the matrix, then carve the occlusal surface from memory, so to speak, afterwards remove the matrix, carve the buccal and lingual proximal sections, then while thoroughly chilled have the patient close the teeth very carefully, if the occlusion be too high, note the point and carve it away.

In cavities which include mesial, distal and occlusal surfaces it will be advisable to fit a band matrix which will encircle the tooth. This may be constructed of thin platinum or silver, and such a matrix when properly adjusted will not interfere in the least with the bite.

The writer has encountered some cavities, however, to which a band matrix could not be adjusted and without which an accurate wax filling for the cavity could not be constructed. One of this character which he was called upon to fill recently was a lower left second molar, the cavity extending from the mesio-buccal angle around to the disto-linhual angle and the gingival margin of which lay about 2 mm. below the gum. The pericemental attachment was practically at the cavity margin and this would have precluded the adjustment of a band matrix even if tge other difficulties to its adjustment could have been surmounted.

The case was operated on as follows:

An impression of the cavity was taken with base-plate gutta-percha, it being possible with this material in a semi-plastic condition to force it slightly over the cavity margin lying beneath the gum. From this impression a cement model was constructed, mounted in the die cup of one of the swaging machines and a $1/1000$ platinum matrix was swaged and carefully trimmed to the gingival margin, then a hole about 3 mm. in diameter was cut in the center of the matrix and it was re-swaged.

This matrix was then adjusted in the cavity and trimmed just flush with the gingival margins, without overlap at any point, then a mass of inlay wax was softened and pressed into the matrix while in the cavity and the patient was allowed to bite on it. This was removed from the matrix and the matrix from the cavity, both matrix and wax were carefully dried, the wax was then placed in position in the matrix and the crevice that was found along the gingival margin between the wax and the matrix was filled by carefully flowing melted wax into it by means of a small spatula; the wax filling now being adherent to the matrix it was replaced in the cavity, it was noted where additional contour was needed and wax was flowed on at that point, when the proper contour

was at last obtained. Matrix and wax filling were removed thoroughly chilled, then with a large spoon excavator, a concavity was cut in the wax through the hole in the center of the matrix; this was to provide for additional mechanical retention of the inlay and may be resorted to in any inlay where the retentive shape of the cavity seems to be inadequate, and the securing of additional retention would jeopardize the stability of the remainder of the crown of the tooth.

Recently Dr. F. E. Roach of Chicago has devised an instrument for hollowing out the wax models without danger of distorting them. It is a very useful instrument and can be procured from any dealer.

Before attempting to hollow out the model or to trim off any overlap which may be found at a point that was not quite accessible to the carving instruments the operator is advised to mount the model on the sprue-former as described below, then the model may be held in a manner that cannot damage the fine marginal edges.

The function of the platinum matrix in the case just referred to, was simply to give a definite edge to which the wax filling could be trimmed to secure an accurate adaptation to this obscure margin so that there would be neither protrusion or recession at the cavity margin, either of which would probably have caused chronic gingivitis. Subsequently, the gold was cast into this platinum matrix which became part of the permanent inlay.

If, upon removal of the wax model from the cavity, it is noted that the margin is faulty or indefinite at any point, this fault may be corrected by chilling the model thoroughly, drying it, pressing a small strip of paraffin upon the faulty margin, replacing the model in the cavity and slowly pressing it to place; the heat of the mouth while not affecting to any appreciable degree the hard wax model will thoroughly soften the paraffin so that simply the gap in the margin will be filled by it; then chill thoroughly; upon removal a definite margin will be found where it was faulty before.

In case of pulpless teeth additional retention may be secured by inserting an iridio-platinum post (about 18-gauge) in the root canal. This should be inserted after the wax filling has been carved. Heat the post (see that it is dry and slightly roughened) and pass it through the wax filling into the root canal; it should be hot enough to melt the wax as it comes in contact with it so that it will pass through the filling without force enough to crowd it from the cavity. When chilled the wax will be adherent to the post and can be removed from the cavity by simply grasping the projecting end of the post and removing it and the filling together.

If matrices or posts are used they should always be of platinum and iridio-platinum respectively, as gold matrices and posts oxidize slightly

when the mold is heated up and the cast gold does not adhere perfectly to them.

The wax filling having been completed and removed, it is washed in cold solution of soap and water by means of a camel's hair or sable brush to remove any film of saliva that may be adhering which would cause a faulty mold, thoroughly chilled in ice water, then a little brass rod about

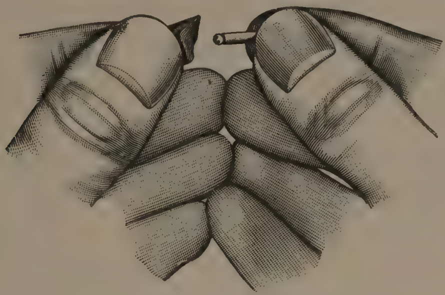


FIG. 291.

FIG. 292.

10 mm. long and 2 mm. in diameter, technically known as a sprue-former, is heated by dry heat, and pressed into the wax at either the occlusal or the proximal surface (Fig. 291), preferably the latter. Recently Dr. H. N. Orr of Chicago has devised a very useful and ingenious little instrument for attaching the sprue-former to the wax model while it is in place in the cavity of the tooth (see Fig. 294).

It consists of a split tube A which holds a sprue former with a slight spring clutch. This is soldered to a nozzle C which has its opening at side B instead of at end, this opening extends through the split tube, at the butt end of the nozzle is attached a rubber bulb D similar to the bulb of the ordinary medicine dropper and which projects through an opening in the side of the hollow handle E. These parts slip together and are held by friction clutch alone.

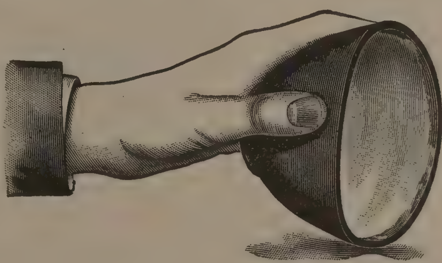


FIG. 293.

The bulb D is first filled with ice-water—then a sprue former is slipped into the split tube, the wax model in the tooth cavity is chilled and lifted from the cavity with an explorer; that one may be assured that it will draw easily, then replaced in the cavity, and chilled again. The sprue former is heated slightly at the tip so that it will imbed itself in the wax model without pressing it out of shape, the instant it is imbedded slight pressure with the thumb on the bulb through the side of the sprue holder (which

should be held as one would hold a pencil), throws sufficient ice-water on the sprue former to chill it and harden the wax where it was softened in imbedding it, and the wax model may be lifted from the cavity.

It will require a little practice to accomplish this as it should be done, but once this little skill has been obtained it affords a splendid method both of removing the wax model and attaching the spure former without danger of marring delicate margins or bending extended arms of the wax model.

After removal of the wax model by this method the sprue-former is

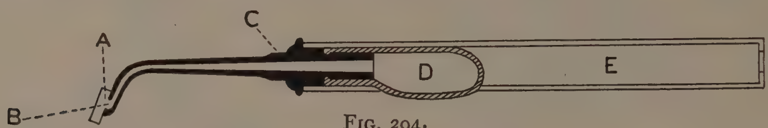


FIG. 294.

easily removed from the holder by grasping it with a pair of pliers just below the split tube and pulling it out.

These instruments have not as yet been placed on the market but one can have one made by almost any instrument-maker. This brass rod is now inserted into the hole in the center of the base plate of the molding flask which consists of a metal ring, and a base plate (Fig. 292). Then the investment or mold material is mixed to about the consistency of thick cream. In mixing this simply sift the compound into the water,

FIG. 295.

avoid stirring it so that there will be no bubbles, complete the mixing by revolving the rubber cup (Fig. 293).

Dr. Taggart has devised two measuring cups, one for the water and the other for the compound which gives just the proper proportions (Fig. 295). The compound sets slowly so that there is ample time for careful, deliberate application of it to the wax model. It should be applied with either a small sable brush or small pointed spatula; a little is laid on at a time and carefully worked into all the corners and angles, especially along the lines of the margins, then after all the surfaces have carefully been covered, more compound is added until the model is covered at all points with an investment about 2 mm. thick.

The wax model should never be chilled just before this first application of the investment, instead it should be dipped in tepid water to bring it

more nearly to the temperature of the mouth. Chilling the model undoubtedly causes it to shrink and warp slightly but it will return to normal size and shape upon being brought to what may be called a tepid temperature—tepid water should also be used in mixing the investment.

Then the case appears simply as a brass rod with a mass of investment material on the end of it (Fig. 296). The ring is about an inch in length, varying in diameter, according to the size of the casting to be made (for by this process a casting as extensive as that of a fourteen tooth bridge may be made), with a small hole in one side near the base to permit the surplus mold material to escape.

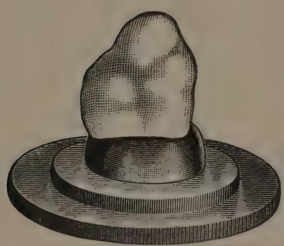


Fig. 296.

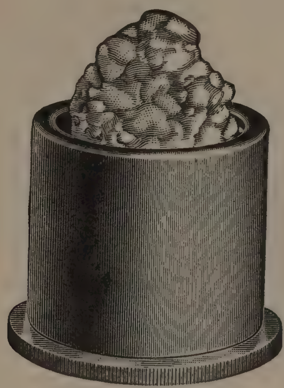


Fig. 297.

The base plate is so constructed, that while it fits into the ring for a couple of millimeters there is also a flange section with a milled edge which extends beyond the side of the flask. In the center of base plate, is a dome and in the center of that there is a hole into which the sprue-former is inserted. Having set the sprue-former in position, put the ring in place on the base plate (Fig. 297) and fill it with the mold material or investment, slowly rotating the flask as you do so.

Build up an excess above the top of the flask, then press a piece of glass plate down upon it which will force the excess through the little hole in the side of the flask. The glass plate is removed by sliding it across instead of lifting it.

Recently Dr. Taggart has devised a new investment which may be mixed so thin that the model may be placed in the flask and the investment simply poured in upon it, a marked advantage as it simplifies the investing.

As so much depends on good investing and as chemical reactions not contemplated in composing the formula of the investment material may occur due to the practice of chlorinating the water supply of cities

it is advisable to use distilled water for investing mixtures and to use vulcanite spatulas instead of metallic ones.

When the investment has set, the flask is heated slightly, then grasping the milled edge of the base plate it is gently turned. This breaks the adhesion of the mold material to it without disturbing the surface and the base plate and sprue-former are withdrawn from the mold. Do not invert the flask in doing this, for if this be done and some of the investment material should flake off it would drop into the sprue hole and result in a flaw in the casting. The base plate should be kept clean and polished at all times, rubbing off the surface after cleaning with a little vaseline.

The base plate and sprue-former having been removed, there will be found a cup-shaped depression in the center (Fig. 298), with a hole leading to the mold. The flask is placed over the Bunsen burner in an oven which has been devised by A. C. Clark & Co., and the case heated slowly, carrying the heat to a point where the wax is ignited. The case is kept at this heat until not only has the wax been burned out, but the residual gases therefrom have also been combusted. It is highly important that the mold be kept intact, to obtain a flawless casting. To insure this, heat the flask slowly and do not subject it to any greater heat than is necessary to consume the wax and its gases.

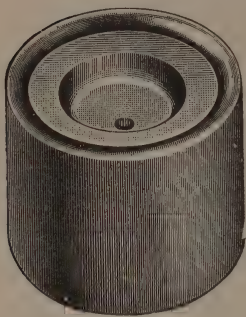


FIG. 298.

Take precautions to avoid chipping the investment about the concavity and the sprue hole, for if these chips should fall into the mold and it frequently is impossible to remove them if they do, they cause a faulty casting and if the fault be along any of the margins, your inlay is ruined beyond repair.

The burning out of the wax and its gases being completed, the flask is allowed to cool, then placed in the flask holder of the casting machine.

It may be well to briefly describe the casting machine. It consists of a device which holds a 100 gallon cylinder of nitrous oxid, has a pressure valve which may be set for the pressure desired, a dial pressure indicator, which registers the pressure under which the gas is released, a blow pipe, a compressing lever, a lever lock, a mold flask holder, and a signal whistle which sounds until the escape valve of the gas cylinder has been closed after the casting has been made, a very valuable little device by the way which prevents the inadvertent loss of a cylinder of gas (Fig. 299).

The flask having been placed in the flask holder, a button of gold

is placed in the cup-shaped depression of the mold and the flame of the nitrous oxid blow pipe is directed against it. The use of the nitrous oxid blow pipe concentrates a small intense flame directly upon the gold, melting it thoroughly without affecting the surrounding mold as the ordinary gas blow pipe flame would.

The button of gold having been melted until it fairly boils, the compressing lever is brought down, thrusting aside and shutting off the

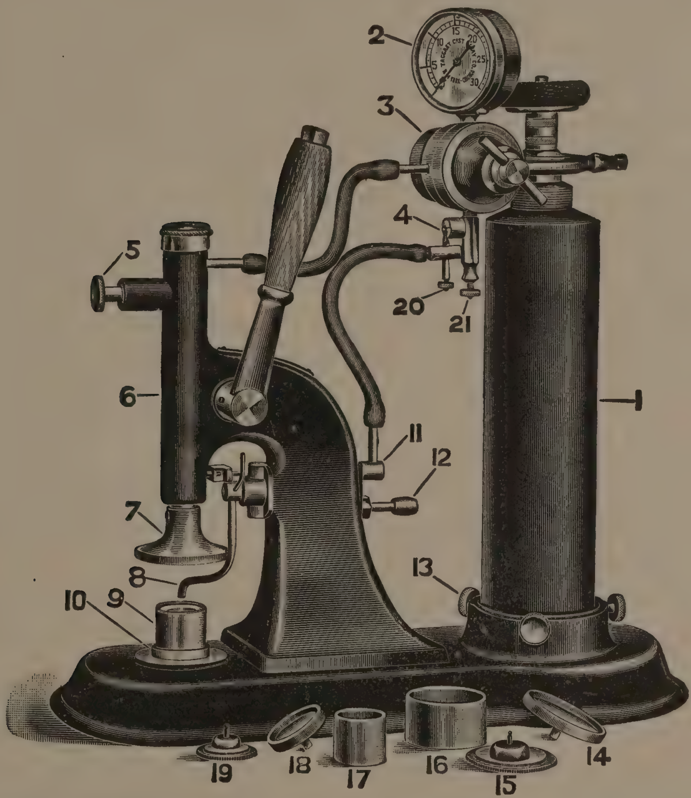


FIG. 299.—1. Cylinder of Nitrous Oxid Gas. 2. Dial pressure indicator. 3. Pressure valve. 4. Signal whistle. 5. Automatic lever locking device. 7. Metal flask cover. 8. Nitrous oxid blow pipe. 9. Mold flask. 10. Mold flask holder. 12. Nipple for illuminating gas connection. 14, 18. Flask holders, large and small. 15, 19. Base plates for flasks large and small with sprue-formers in place. 16, 17. Large and small flasks. 21. Control valve for nitrous oxid to blow pipe.

blow pipe, forcing a metal cover, with asbestos rim packing to make it pressure tight, upon the flask ring and releasing upon the molten gold a gas pressure of about twelve pounds from the gas cylinder, forcing it into the mold in the center of the flask, the residual air being driven into the minute pores of the mold investment ahead of the gold.

The various operations are done automatically by the downward

sweep of the compressing lever. The whole operation is practically instantaneous, the molten gold has no opportunity to cool and solidify until it is forced into the mold; the gas pressure is confined absolutely to the mass of gold and is sustained while it is cooling, and therein lies the main factor of success of this method.

The flask is cooled, the investment broken out and a gold casting, the duplicate of the wax filling with a metal sprue attached is found.

The metal sprue is cut off with a fine saw or pair of nippers, the gold inlay is immersed in hydrofluoric acid for a short time to remove the particles of investment material that will be found fused to it, then washed, boiled in sulphuric acid and washed again. Frequently the outer surface will need little or no polishing save at the point where the sprue was attached, so perfectly may castings be made by this process if the wax filling be carefully finished and all the various steps carefully carried out.

Before attempting to try the inlay in the cavity, examine the cavity surface of the inlay carefully for little gold beads which may be readily removed with a fine sharp excavator.

After trying in the inlay, if it should be found that the proximal contour is insufficient, this may be added to by simply flowing on a little 22-K solder at that point. It has been found by experience that it is best not to reheat the flask before placing it in the machine; it must be perfectly dry, however, otherwise there will be a regurgitation of steam that will either blow the gold out of the depression when it is molten or prevent the complete casting, according to the amount of steam developed and confined.

Inlays should be cast the same day that the investment is made, the results are not so perfect when molds are allowed to remain over night before casting.

When small inlays are to be constructed, as is often the case, in cavities in bicuspids or the anterior teeth, an ordinary pin may be used instead of the regular sprue-former, this pin is heated and the point of the pin is placed in the model while it is in the cavity of the tooth, then, after removing, a mass of wax is placed in the hole in the base-plate of the flask and the head of the pin set into it.

Scrap gold should not be used for casting inlays. After many experiments the writer advises that the usual inlay be cast of an alloy of 3 parts 24k gold and one part 22k solder.

If the inlay is very extensive and is to be subjected to heavy stress of mastication, cast it of an alloy of pure gold with five per cent of platinum, using a block of magnesia as a melting block instead of one of charcoal.

After setting, but before the cement has hardened, burnish all margins that cannot be reached with a disk, then polish the margins accessible to a

disk, running the disk across the margins at right angles and from the inlay towards the tooth; this spins out and burnishes down a fine margin of gold so thoroughly that after this polishing is completed no cement is visible even under a magnifying glass.

As to cements for setting, the writer advises the hydraulic cements.

The effectiveness of this casting device may be appreciated when you are informed that by it clasps may be perfectly cast of clasp gold.

With this casting machine has been cast gold crowns upon platinum bases; bridge sections even up to those embracing the entire arch; clasps; retaining splints; partial plates; and even full plates may be cast.

There is no question by what Dr. Taggart's invention of appliance and process marked a new epoch in both operative and prosthetic dentistry; its value is such that the profession and the public are under obligation to him.

Since his demonstration of appliance and process other appliances for casting have been devised and presented. One very ingenious machine was originated by Dr. Jamieson, of Indianapolis. It casts by centrifugal force, the flask having a swivel handle is hung from a hook at the end of a horizontal rod about a foot long attached to an upright rod which is revolved by the release of a spring at the rate of about 3oco revolutions a minute.

Another device originated by R. C. Brophy, of Chicago, casts by suction, a partial vacuum being created. Still another device, the originator of which the writer cannot ascertain, casts by means of steam pressure. A pad of moistened asbestos is jammed down upon the flask, the heat of the molten gold developing steam of sufficient pressure to force the gold into the mold.

All these methods, however, are based upon that of Dr. Taggart's, in that they employ a wax filling as a model and a flask for the mold identical with his, and it may be remarked that these were the most important factors of his invention, the solution of the casting device being the least difficult of the problems.

The writer has tried all methods and devices for casting and after many experiences states unequivocally that Dr. Taggart's appliance has a wider scope and produces more uniform and more perfect results than does any other. He holds no brief for the gentleman and is under no greater obligation to him than is any and every member of the profession. The statement is made simply because it is a fact.

This process supplants all others because better results can be obtained with less labor for the operator and less loss of time for both operator and patient.

Just a word of serious warning in closing this chapter to those about to

employ this method. Do not imagine that it discounts care and skill. One may think it is no trick at all to construct a wax filling for a cavity, but let me assure you, and experience will emphasize it, that it requires all the skill and patience you possess most of the time to properly construct this wax filling and you will probably be discouraged with the process and your endeavors, until you have mastered the manipulative technique; for faulty wax fillings will invariably result in faulty inlays.

Skill, care and cleanliness must be observed in all steps of this process. Once the manipulative technique peculiar to this process has been mastered, one will discover that instead of discounting, it puts a premium on individual skill and carefulness. For by this process more uniform and better results with less labor may be obtained than have therefore been possible with any process at our command. After subsequent observations of many years, it is evident that careful technique is the most important factor in the successful production of gold inlays.

CHAPTER XVIII

THE TREATMENT OF EXPOSED OR NEARLY EXPOSED PULPS

BY J. P. BUCKLEY, PH. G., D. D. S., F. A. C. D.

GENERAL CONSIDERATIONS

In the practice of dentistry there are problems continually arising wherein it is difficult for the conscientious operator to decide upon a method of procedure which will conserve the best interests of the patient. There is no condition confronting us with greater difficulty than in those cases where the decay has extended to such a depth that its thorough removal will expose or nearly expose the pulp. The problem to be solved here in all such cases is to decide whether it will be best to try to save the pulp or to anesthetize or devitalize this organ, remove it and subsequently fill the canals.

There are several important factors to be considered, and upon which will largely depend the success or failure following an attempt to save the pulp after it has actually been exposed. In an accidental exposure in the preparation of a cavity, the chances for saving the pulp, provided the injury has not been too great, are far more favorable than if the pulp had been exposed by the necessary removal of carious dentin. Our success will also depend in no small degree upon the condition of the pulp as well as upon the general condition of the mouth of the patient in which the exposure occurs. If there is congestion or any evidence of degeneration of the structural components of the pulpal organ itself, it would be futile to attempt to cap it, as would be also any attempt to permanently save a pulp in the mouth of a patient who was suffering from some systemic derangement interfering with the general circulation, thus lessening vital resistance; for in such cases the pulp would fail to receive from the blood supply the necessary elements for the restoration of its functional activity. Logan is of the opinion that most pulps, the exposure of which, has been brought about by caries, have undergone sufficient inflammatory changes to cause their ultimate death, even when carefully capped.

The general condition of the mouth itself and the care it receives daily

from the patient, is an essential factor to be taken into consideration before proceeding to cap a pulp. Dr. S. A. Hopkins, of Boston, in a carefully conducted series of experiments to ascertain the difference in virulency of certain pathogenic bacteria in different mouths, and in the same mouth under different conditions, proved that not only did the germs proliferate more rapidly in neglected and uncared-for mouths, but their pathogenic properties are greatly increased. Recent investigation along this line has determined the fact that the *streptococcus* germ, in varying gradation, is almost universally present in carious dentin.

There is one class of cases of pulp exposure which frequently presents in a busy practice and in which it is our plain duty to make the attempt to restore the organ to its normal function, even though the conditions for doing so are not altogether favorable. I mean here those cases in the mouths of young patients where the pulp is exposed from decay and the roots of the tooth have not been fully developed. Every effort should be made to cap such a pulp and thereby save it, if for only a year or two, for clinical experience has demonstrated that to remove the pulp and properly close the large openings in the end of the roots is, at best, a difficult procedure; that a tooth in this condition, thus treated, is usually a source of annoyance and its usefulness generally of short duration.

In another class of cases the author also believes that we are justified in capping the pulp. For instance, in those cases of exposure where for certain reasons it is desirable to save the tooth, and on which it would be difficult to adjust the rubber dam, aseptically remove the pulp and thoroughly fill the canals. I wish to state here, however, that I do not mean to infer that a pulp should be capped in an anterior tooth, because of the liability of the tooth structure discoloring after the pulp has been removed. This phase of the subject will be referred to in detail in a subsequent chapter on pulp removal under the preservation of the color of the tooth.

From the foregoing, then, it should readily be understood that no set of rules can be given, the application of which will surely lead to success. Every case must be studied and treated according to the operator's best judgment after having taken into consideration all these various factors.

CAPPING THE PULP

There are several methods of capping the pulp, each differing in minor details, such as the use of various cements, gutta-percha, concave metallic discs, etc., etc. In the remainder of this chapter attention will be directed to the general precautions to be taken in following the different methods of capping; after which one method will be described in detail which has proved successful in the author's practice. By this I do not mean to

convey the idea that all pulps which I have attempted to save have been rehabilitated to their functional activity—many have not; however, a sufficient number of those thus treated have remained quiet, and proved years later to be vital, to justify making the attempt where the case demands.

Precautions.—The precautions to be observed in following any method are:

(1) By the use of an anodyne, the hyperemic pulp, if in this condition, *must be restored to normal* before the final capping.

(2) The dentin overlying the pulp *must be thoroughly sterilized.* It should be noted here that the usual perfunctory method of sterilizing the dentin by simply applying a germicidal solution to the cavity for a few moments does not sterilize to the degree necessary for successful results. The lack of thorough sterilization has, without doubt, been the chief cause of failure. The accuracy of this statement will be seen when we remember that our greatest success has followed the capping of pulps which have been accidentally exposed with a bur or instrument in preparing a cavity, although, in most cases, greater mechanical injury had been caused than when the exposure was due to caries or the removal of carious dentin.

(3) Pressure in applying the material for capping, or the cement which covers the capping, *must be avoided.*

Technique.—After breaking down all overhanging edges of enamel and removing as much of the debris and softened dentin as can be done without pain or injury to the pulp, the cavity should be flooded with a mild, non-irritating, antiseptic solution, previously heated to the temperature of the body. For this purpose the author suggests the use of peppermint water to which 95 per cent phenol has been added in the following proportion:

℞ Phenolis, f.ʒ j
Aquæ menthæ piperitæ, f.ʒ vj—M.
Sig.—Use wherever a mild, non-irritating antiseptic solution is indicated.

This solution can be further diluted, if necessary, and used with a water syringe, before applying the rubber dam, thus adding comfort and cleanliness to the operation. Physiologic salt solution may also be used here. The excess can now be absorbed from the cavity with cotton and the dam adjusted. By using some obtunding remedy and a sharp spoon excavator, or oftentimes a large round bur in the engine, the carious dentin can be removed. If, however, the thorough removal of all the softened dentin would make a large exposure, it is best to leave the layer overlying the pulp and depend upon the sterilizing agent, rather than to jeopardize

the life of this organ by the injury thus produced. The delicate pulp tissue will not tolerate much abuse and remain quiet, therefore if it is injured to any great extent it had better be removed at once. The dentin can now be sterilized by sealing in the cavity, for a week or two, the following remedy which is not only germicidal in action, but possesses marked anodyne properties as well:

℞—Menthol,	gr. xx
Camphor,	gr. xl
Phenolis, (U. S. P.)	f. ʒ iij—M.
Sig.—Use as directed.	

This remedy is known as the author's *phenol compound.*

It is best to seal with a veneer of quick-setting cement, previously filling most of the cavity with cotton, thereby avoiding pressure and facilitating the subsequent removal of the dressing. By this means the dentin can be thoroughly sterilized, and the pulp, if at all hyperemic, as it is likely to be, will return to its normal condition.

At the next sitting, the case giving a favorable history for the interval, the dam should always be applied, the teeth included sterilized and the previous dressing carefully removed, when the exposure and dentin immediately over the pulp can be gently covered with a thin paste made by mixing pure precipitated calcium phosphate with phenol compound, oil of cloves, or eugenol. The paste should be placed on one side of the cavity and gently coaxed over the exposure in such a manner as to exclude the air. I desire to emphasize the importance of covering the entire dentin immediately over the pulp, as well as the exposure, with this antiseptic and non-irritating paste. By this means we prevent the phosphoric acid of the cement, used to cover the paste and to temporarily fill the cavity, from irritating the pulp. It is best, as intimated here, to fill the entire cavity with cement and wait for a few months or perhaps a year before inserting the permanent filling or inlay. Advantage should be taken of every possible means of preventing subsequent irritation to the pulp. For this reason largely the author uses precipitated calcium phosphate instead of calcined zinc oxid, which latter substance is recommended by many writers. The powder (largely zinc oxid) which comes with a package of cement is supposed to be chemically pure. Those who are familiar with the science of chemistry, however, know that arsenic is found associated in nature with many of the metals, among which is zinc; and, while it can be done, it is difficult to obtain these metals or their oxids free from arsenic. It is well, especially in those cases where the pulp is not quite exposed, to add a small amount of either *aristol* or *europhen* to the paste. These are iodin compounds and are used as substitutes for iodoform. Both are tasteless,

practically without odor, and insoluble in water, but soluble in the *oil* used as the vehicle for the paste, therefore only a small amount should be added.

In closing this chapter, I desire to emphasize the importance of studying carefully the conditions as found in each case; and to say that the opportunity here for exercising good judgment is very great, and that there is a satisfaction in realizing, whether we succeed or fail in our effort to save the pulp, that we did our duty as we saw it.

CHAPTER XIX

THE ANESTHETIZATION AND DEVITALIZATION OF PULPS, THEIR REMOVAL, AND THE SUBSEQUENT TREATMENT

BY J. P. BUCKLEY, PH. G., D. D. S., F. A. C. D.

GENERAL CONSIDERATIONS

Embryologists claim that when the roots of a tooth are fully developed, the pulp has no further function to perform. If this theory can be accepted as correct, and I think that it is quite well established, it would appear from the large percentage of failures following the most careful methods of pulp capping, that the safest, and, therefore, the best practice would be *to destroy the vitality and remove the pulp* in all cases where this delicate and susceptible tissue had been previously irritated for any great length of time, unless, as explained in the foregoing chapter, there was some special reason for attempting to restore the organ to its functional activity. From sad past experience the author has been led to adopt this general practice. By this I do not wish to convey the idea that it is advisable or necessary to miscellaneously or ruthlessly destroy pulps, for such is not the case. It is the plain duty of every dental practitioner to save the pulps of teeth, if it can be done with any reasonable degree of success. Dentists are delving into pathology today more than ever before; and a knowledge of the pathology of the pulp, whereby one may be able to interpret the clinical symptoms, is essential in arriving at a proper decision as to whether the pulp should be saved or destroyed. There are many conditions, however, which necessitate the removal of the pulp, such as:

(1) *Dental caries*, or the invasion of pathogenic bacteria and the absorption of toxins. This is the most prolific source of pulp irritation.

(2) *Mechanical irritation*, due to such causes as abrasion, thermal changes, close proximity of metallic fillings, injudicious regulating, excessive grinding, etc.

(3) *Calcific deposits*, or pulp nodules within the pulp itself. These calcific bodies result from slight but continued irritation of the pulpal organ.

(4) *Crowning teeth and filling large cavities.* It is usually difficult to grind a vital tooth sufficiently to adjust the band for a crown properly, without irritating the pulp and thus endangering its life. Sometimes in filling teeth it is advisable to remove the pulp in order to properly anchor a large filling or inlay.

(5) *Pyorrhea alveolaris.* Frequently in treating this disease, where the pockets are deep requiring surgical eradication and where the infection in the apical area has left the pulp in a low state of vitality, the best results are obtained by removing the pulp. It should be remembered here that no such tooth should be left in the mouth unless the infection associated therewith has been completely removed.

Factors to be Observed in Removal of Pulp.—Having considered all of the conditions and deciding that the removal of the pulp is indicated, the method by which this can be accomplished with the least inconvenience to the patient and to the operator is the most important consideration. Whatever method is employed in the removal of pulps from teeth and the subsequent treatment, there are at least three factors to be observed, viz.:

(1) Establish and maintain asepsis in performing the operation.
(2) Preserve the color of the tooth.
(3) Thoroughly fill the root.

METHODS

I. *Anesthetization.*—In the author's opinion a very satisfactory method of removing pulps from teeth, to both patient and operator, all things considered and conditions being favorable, is to anesthetize the tissue by the use of various strength solutions of local anesthetic agents. The solutions are forced or carried through the dentin and into the pulp by means of pressure or the electric current.

(1) *Pressure Anesthesia.*—By pressure anesthesia is meant the process of anesthetizing the pulp by forcing solutions of local anesthetics, usually cocain hydrochlorid, into the tissue by means of pressure. The pressure is applied either by using unvulcanized rubber or gutta-percha, and a blunt instrument, or by specially devised instruments for this purpose. There are many such instruments on the market; and while they are often an aid in accomplishing the ultimate result, they are not an absolute necessity.

The rubber dam should be employed in every case where it is possible to adjust it, and the teeth included sterilized. In cases where the dam cannot be adjusted, it would doubtless be best to remove the pulp by the devitalization method, to which reference will be made later in this chapter, for in using the method under consideration care must be taken to prevent pericementitis following the operation; and one of the precautions to be observed in preventing this result is to *thoroughly sterilize* the cavity before

applying the pressure. It should be remembered that the majority of canals which contain live pulps are sterile, generally speaking, and if they become septic at any time before the root is filled, it is the fault of the operator. Thus the importance of always adjusting the rubber dam, using sterile instruments, and having in a convenient and conspicuous place an aseptic doily on which to wipe the blood and dry the instruments used.

Attention is again directed to the fact that the usual custom of applying coagulating agents, such as phenol, cresol, etc., to the cavity for a few seconds, does not sterilize the dentin to the degree desired. The best results are accomplished by employing germicidal agents which are soluble in water. In cavities where the decay is not too deep, the dentin can be sterilized by the use of a 10 per cent solution of formaldehyd to which 5 per cent of sodium borate (borax) or sodium carbonate has been added. Where the decay is near the pulp this solution is liable to cause pain, in which case the same result can be accomplished by the use of a 1:500 solution of mercury bichlorid. In using the latter solution the pliers on which the remedy is applied should be wiped immediately on an aseptic doily to prevent the mercury from acting upon the instrument. One of the best solutions with which to chemically sterilize the dentin, especially in those cases where the cavity has previously been filled and the tubuli are closed and perhaps there is secondary dentin, is a 25 per cent solution of sulphuric acid. The late Dr. Geo. W. Cook, of Chicago, recommended the use of pure sulphuric acid for this purpose. The author's phenol-sulphonic acid may be used here far more conveniently. The solution can be applied to the floor of the cavity, being careful not to get the agent on the crown of the tooth. After a few minutes the excess can be neutralized with a solution of sodium bicarbonate. After the dentin is sterilized the cavity should be desiccated with warm alcohol and gentle heat, when we are ready to use the anesthetizing solution. Before taking up the technique of this method, however, I desire to emphasize the importance and necessity of cavity sterilization. In our discussion later of the devitalization method, it will be pointed out that the carious and infected dentin can be completely and painlessly removed after the devitalizing agent has been applied, thus *mechanically* sterilizing the cavity; but in the anesthetization method the infected dentin is sensitive and cannot be removed without unnecessarily producing pain. The dentin in this case must, then, be sterilized by *chemical* means, for to force the anesthetizing solution through the dentin without previously sterilizing it, means the forcing of microorganisms, and perhaps poisonous ptomains, into the pulp tissue and many times into the tissue surrounding the apical end of the root, for it is difficult to force the solution to, and only to, the apex; thus too much

pressure and the lack of thorough sterilization constitute a prolific source of pericementitis following the removal of pulps by this method.

With the cavity thoroughly sterilized we are now ready to use the anesthetizing solution, which should be made at the time. For this purpose the crystals of cocain hydrochlorid, previously powdered, should be used as the base, and freshly distilled or boiled water as the vehicle. In my own practice I use "cocain points" or "procain points," which are compressed points or cylinders of pure cocain hydrochlorid or procain containing 1/12 grain (.005 gm.) each, as the base and my regular local anesthetic solution as the vehicle for making the stronger solution. A prescription for the regular local anesthetic solution here follows:

℞—Cocainæ hydrochloridi,	gr. vj
Phenolis,	m. ij
Sodii chloridi,	gr. j
Aquæ menthæ piperitæ,	f. ℥ j—M.

Sig.—Use as a local anesthetic for hypodermic injections.

The cocain hydrochlorid points not only insure a pure specimen of the drug, but facilitate making the solution, as they are so readily soluble. There is no advantage in using the above solution over distilled or boiled water or freshly prepared peppermint water or physiologic salt solution, except that the solution is always at hand in a convenient container and is sterile.

The thumb and forefinger with which cotton is to be wrapped around the broach should be sterilized by dipping a large pledget of cotton in the 10 per cent formaldehyd or 1:500 mercury bichlorid solution and rolling this between the thumb and finger. A small amount of the alkaloidal salt is now placed on a clean glass slab and a pledget of cotton, dipped in the vehicle selected, a few drops of which have previously been placed on one end of the glass slab or in a clean glass watch crystal or other container, is gently placed in contact with the drug, when the latter readily dissolves, making a strong solution. It is never necessary to make a saturated solution, for oftentimes better results will be obtained, especially if the solution is to be forced through the dentin, if the strength of the solution approximates only 4 or 5 per cent.

The cotton thus saturated is placed in the cavity as nearly over the pulp as possible. A piece of unvulcanized rubber which will approximately fill the cavity is selected and passed through the flame. There are two objects in doing this: It sterilizes the rubber, and also makes it more pliable in which form it conforms readily to the cavity of the tooth. The rubber is now placed in the cavity, and by means of gentle but firm pressure with a suitable blunt instrument the solution is forced through the dentin and into the pulp. If there is any evidence of pain as the pressure is applied, it should be stopped for a moment, but never

released. The slight pain is only momentary and is an indication that the solution is being confined under the pressure, which is essential for the success of this method. In lower teeth, or other favorable cases, a cocain or procain point may be placed directly in the cavity and the moist cotton added, making the solution therein. It may be necessary in those cases where there is considerable dentin between the cavity and the pulp to make two or three applications before the pulp is reached without pain, after which one application should complete the thorough anesthetization of the organ. After the first application a small depression can be drilled into the dentin toward the pulp, in which the solution can subsequently be placed, thereby aiding materially in confining the solution under the pressure. When an exposure exists it requires but little pressure to anesthetize the pulp. In these cases the anesthetic agent can be placed in the cavity near or over the exposure and the pulp gently pricked with a sharp explorer, causing it to bleed; this if done carefully will produce very little pain. The blood will dissolve the selected drug, when pressure can be applied and the pulp anesthetized. In doing this, however, there is greater danger of forcing the blood into the tubuli of the dentin of the crown of the tooth, thereby making it more difficult to remove the blood. Care should also be taken not to force the solution any further than is necessary for the painless removal of the pulp, for it should be noted here again that cocain is a general protoplasmic poison, and if even weak and sterile solutions are forced past the apices of the roots pericementitis is almost sure to follow.

When the pulp is anesthetized the pulp chamber should be opened into in such a manner as to expose the canals. This is best accomplished with a large round or inlay bur by means of which the entire roof of the chamber can be obliterated. A bur suggested by the author for this purpose is simply a large inlay bur with the end rounded. In opening into the pulp chamber of molar teeth care should be taken not to disturb the floor of the chamber, for by so doing we are liable to add to the difficulty of entering the canals with a broach. While we are never justified in drilling unnecessarily for the purpose of freely exposing the canals, it is, if necessary, far better to weaken the crown of the tooth somewhat by this means rather than leave a portion of the pulp in an inaccessible canal which may decompose and subsequently cause periapical infection.

The selection of a proper broach is an important matter. Every broach should be tested before entering the canal. This can be done by bending it in various directions. If the broach is weak in any particular place it can be detected by this means; thus we avoid breaking the broach in the canal, the removal of which is often a difficult pro-

cedure. Many good operators claim to be able to remove all pulps by using a smooth, three-cornered broach on which a few threads of cotton are wound. Others use twist or spiral broaches. In all large canals the author has had the most satisfaction from the use of a barbed broach. The broach should be gently worked along the side of the canal as far as it will go without using too much force, twisted once or twice to entangle the pulp, and then withdrawn. By this means the pulp can be removed from large canals in its entirety.

In the removal of live pulps by the anesthetization method, there necessarily would be more hemorrhage than in those cases where the pulp was devitalized before attempting to remove it. However, the control of hemorrhage is not as difficult a procedure as many writers have led us to believe. In most cases the hemorrhage, if undisturbed, will be checked by nature's method in a few minutes; after which the blood in the cavity and canal should be *thoroughly removed.* I desire here to emphasize the importance of *removing* the blood. One of the factors to be observed in extirpating pulps from teeth and the subsequent treatment, is to *preserve the color of the tooth.* The cause of many teeth darkening after the pulp has been removed, can be traced directly to the failure to remove the blood from the dentin of the crown of the tooth. The far too prevalent practice of wiping out the bloody canal with a solution of hydrogen dioxid, blindly thinking the blood can be removed by this means, cannot be too strongly condemned. The hydrogen dioxid simply decomposes the blood within the tooth structure, oxidizing the iron of the hemoglobin; and the gases evolved in the decomposition force this pigment into the tubuli, which, if left (and it is difficult to remove it), will cause the tooth to subsequently darken in almost every instance. In a subsequent chapter the author expects to show that ferric oxid is largely responsible for the discoloration of teeth from pulp decomposition. Therefore we should avoid forming within the tooth structure the pigment which we know will discolor teeth. *The color of a tooth does not depend upon the life and vitality of the pulp, but upon the array of colors in the dentin which are reflected through the nearly colorless and transparent enamel.* If, then, these colors are not changed by our failure to remove the blood or by the use of staining remedial agents in the subsequent treatment following pulp removal, the tooth will not discolor.

To remove the blood from the canal, alcohol can be used, or even better than this agent is nature's greatest solvent, water. The water should, of course, be sterile, and the same specimen can be employed here as was used in making the anesthetizing solution, *i.e.*, freshly distilled or boiled water, or peppermint water to which two minims of phenol

has been added to the fluid ounce. If convenient, a little sodium chlorid (common salt) can be added to the water. Physiologic salt solution (normal saline) is an excellent solution to use for this purpose. By this means the blood can be completely *removed*, not decomposed in the canal and forced into the structure of the tooth.

There are many canals so small and tortuous that even a fine broach will not enter, to any depth at least. In these cases, after the hemorrhage from the larger canals has been checked and the blood removed, the pulp tissue in the small canals can be disorganized by the use of strong solutions of mineral acids or alkalies. The author formerly recommended making a paste of sodium dioxid and absolute alcohol, placing the paste in the pulp chamber over the small canals, and working it down as far as possible with a smooth broach. The alcohol gradually evaporates, when the sodium dioxid can be decomposed into oxygen and caustic soda by placing a pledget of cotton in the cavity moistened with distilled water. After the reaction has taken place, the alkali can be neutralized with a weak solution of sulphuric acid (2 per cent). This process can be repeated until the desired end is attained. There are other means by which the same result can be accomplished, such as the use of pure phenolsulphonic acid, a 30 per cent solution of chemically pure sulphuric acid, strong solutions of sodium or potassium hydroxid, or a mixture of metallic sodium and potassium (Schreier's paste). These same agents, especially the phenolsulphonic acid, can be used to advantage for the purpose of disposing of a remnant of a pulp in larger canals. It is not safe to anesthetize this remnant by means of pressure. The only cases on record to my knowledge, where toxic symptoms have resulted from the removal of a pulp by pressure anesthesia, followed an attempt to anesthetize a remnant of a pulp or in making the second application of the anesthetizing solution.

After the pulp has been removed and the canals dehydrated with alcohol and heat, and *anodyne* treatment is indicated. For this purpose such drugs as phenol, oil of cloves, or eugenol can be employed. The author suggests here eucalyptol compound to which mention will be made in the chapter on The Treatment of Non-Septic Pericementitis (page 321). In using any of these remedies, especially the last named, it is best to insert dry cotton in the canal and then place a pledget dipped in the remedy in the pulp chamber and seal with a combination of temporary stopping and cement. The heated stopping (good grade) is placed immediately over the eucalyptol compound dressing, adhering to walls of the cavity; the excess is removed and the remaining portion of the cavity is filled with cement. This combination insures a hermetically sealed cavity, which is important here. The dry cotton in the canal will absorb the moisture from the apical end of the root and the anodyne remedy from the pulp

chamber. There is an advantage in using the dry cotton, for it is almost impossible to completely dehydrate the canal at this sitting. If asepsis has been maintained in removing the pulp all that is necessary is to keep the canal in this condition until the root can be filled. The canals should not be filled at the sitting at which the pulp has been removed by pressure anesthesia unless there be some exceptional reason for doing so. There are many good reasons why the canal should not be filled at this sitting:

(1) While it is our object to force the solution just sufficiently to anesthetize the pulp, our main object is to remove the pulp *absolutely without pain*, and it is very difficult to force the solution to the end of the root without forcing it through the apex and anesthetizing the tissue in the apical area to some extent. With the tissue anesthetized we would have no guide as to when the root was thoroughly filled.

(2) The tearing away of the pulp from its connection at the apex causes more or less irritation, and a few days should elapse to give nature a chance to readjust the condition. The root filling would only serve at this time to further irritate the tissues.

(3) Sometimes with the utmost care in removing the pulp, secondary hemorrhage ensues with the formation of a clot in the apical area, causing soreness, in which case greater comfort can be given the patient by the proper treatment through the root canal than simply by counterirritation or external treatment only.

At the second sitting, the case giving a favorable history, the canals should be filled.

There are cases occasionally where nature does not stop the hemorrhage as readily as we desire. In these exceptional cases the hemorrhage must be stopped by artificial means, even at the possible expense of producing pericementitis. Cauterizing agents are useful here. For this purpose 95 per cent phenol, a 50 per cent solution of phenolsulphonic acid, or a 15 per cent solution of trichloracetic acid, can be worked down into the canal against the injured and bleeding tissue, after which the anodyne treatment is employed as usual. Where the above treatment does not produce the desired result, cotton saturated with a fresh 1 : 1000 solution of adrenalin chlorid can be placed in the canal and with unvulcanized rubber forced into the tissue beyond the end of the root. This should only be used in extreme cases because of the soreness it is liable to produce.

In this connection I desire to discuss the use of solutions of adrenalin chlorid as the vehicle for making the anesthetizing solution, or the use of adrenalin chlorid and cocain hydrochlorid tablets for enesthetizing the pulp. The adrenalin chlorid has been suggested as a means of *preventing* hemorrhage. Now, it ought to be evident to any one who has studied this subject that to prevent hemorrhage by the use of any hemostatic agent, it is necessary to force the agent into the tissue from which the hemorrhage

comes. Therefore, to get the effect of the adrenalin chlorid in removing pulps by pressure anesthesia, it is absolutely essential that the anesthetizing solution which also contains the hemostatic agent, be forced through the apex and into the apical area—the very thing we have been taught, from sad experience, not to do. When we remember that the majority of pulps we are called upon to remove are those in which there is, or has been, more or less pulpitis, and when we remember also that pathology teaches that this condition is frequently associated with pericementitis, it is questionable whether or not we ought to prevent hemorrhage in removing pulps from teeth. For to permit the escape of blood from the hyperemic tissue at the end of the root, is one of the best means of aiding nature to readjust the abnormal to the normal condition. In case the primary hemorrhage has been prevented by the use of hemostatic agents, such as adrenalin chlorid, secondary hemorrhage is almost certain to follow with the formation of a clot, the absorption of which in the apical area is an extremely slow and tedious process.

In removing pulps by pressure anesthesia without employing instruments devised for this purpose, the best results are obtained in cases where there are four walls to the cavity, for in this condition the solution is easily confined under the pressure. In proximo-occlusal cavities, the missing wall can be built temporarily with gutta-percha or cement. This is seldom necessary, however, if, in packing the rubber in the cavity, care be taken to cover the gingival wall first and thus seal at this point, then working the rubber over the occlusal and gradually creating the pressure. Whatever means is adopted for the purpose of confining the solution, we must avoid having the solution escape at the gingival margin of the cavity and thereby be forced into the gum tissue and pericemental membrane. The cause of many sore teeth following this method of removing pulps can be traced to carelessness or ignorance in this regard. As stated elsewhere in this chapter, there are many ingeniously devised instruments on the market, the use of which is often a material aid in confining the solution under pressure and forcing it through the dentin. The same precautions should be observed in using any of these instruments as have been emphasized in the application of pressure by other means.

(2) *Cataphoresis.*—Cataphoresis is a term applied to the process of carrying medicinal agents in solution into the various tissues and organs of the body by means of the electric current. In years past there were a variety of cataphoric outfits on the market. Today the method is practically obsolete. To anesthetize a pulp by this means the tooth should be insulated by the rubber dam, care being taken that no moisture escapes from the gum. A small pledget of cotton saturated with the anesthetizing solution is now placed in the cavity, the positive electrode

applied to the solution, and the negative electrode, moistened with water, applied to some part of the patient's body, usually the hand, thus completing the circuit. A steady and continuous current is desired and the perfected instruments are so devised that the amount of current can be measured. The time required to anesthetize the pulp by this means depends largely upon the density of the dentin and the perfection of the instruments used. With the pulp anesthetized, the same method of removing and the subsequent treatment is followed as in pressure anesthesia. Cataphoresis, while successful in the hands of those who mastered the technique, never became popular, largely because of the time required to accomplish the result and because of the complicated and expensive apparatus necessary.

If the method of anesthetizing the pulp be followed and the precautions observed as detailed in this chapter, it will be found that there are few pulps which will not yield to the influence of cocain hydrochlorid. It takes time, however, to adjust the rubber dam, sterilize the cavity, remove the pulp and blood from the canal and seal in the anodyne remedy. Many times the operator is not able at this sitting to give the necessary time to complete this operation. There are cases also where the condition or the location of the tooth in the mouth is such as to make the removal of the pulp more favorable by another method which will now be considered.

II. *Devitalization.*—In the chapter on The Treatment of Sensitive Dentin under the subject of escharotics or caustics, reference was made to the fact that there were many drugs belonging to this class of agents that could not be employed in the treatment of sensitive dentin, for the reason that they were penetrating and had the same deleterious effect upon the cells of the pulp tissue as upon the dentinal fibrillæ. Some of the agents which cannot be used for allaying the sensitiveness of dentin are exceedingly valuable and are employed for the purpose of destroying the vitality of the pulp, thus aiding in its painless removal. The most prominent of these agents is *arsenic trioxid*, (As_2O_3), formerly called arsenious acid. The author is again gratified to know that the later editions of the United States Pharmacopeia recognizes this agent by its correct chemical name, for he was never able to understand why a true *oxid* should be called an *acid* by our legal authority. Arsenic trioxod was introduced to the dental profession in about 1836 by a Dr. Spooner, of Montreal. The agent was first advocated to be used in the treatment of sensitive dentin; for Dr. Spooner discovered that by sealing the drug in a cavity for a few days the most sensitive dentin yielded to its influence. The fact, however, that nearly all teeth thus treated subsequently gave trouble because of the death of the pulp and the usual sequelæ, led the profession to abandon this agent for the purpose for which it was intro-

duced; but it has ever since been used as a means of destroying the vitality of the pulp. In fact, for years it was the only agent employed with any satisfaction.

There has been much difficulty experienced in the use of arsenic trioxid, largely because of the uncertainty of the preparations employed. Many arsenical preparations are on the market. The white powder can be used by moistening a small pledget of cotton with some liquid, such as phenol, cresol, creosote, or oil of cloves, then by touching the cotton to the powdered arsenic trioxid, a sufficient amount will adhere which should be transferred to the cavity and sealed, preferably with cement. It is well for each operator to select an arsenical preparation with which he can obtain good results, and then this should be used to the exclusion of all others. By this means only can we become thoroughly familiar with the action of the preparation employed. The author prefers fiber made from a paste, a formula for which is here given:

℞—Arseni trioxidi,	ʒ j
Cocainæ,	gr. xx
Thymolis,	gr. v
Lanolini, q. s. ft. thin paste	—M.

Sig.—Apply a small amount to the dentin immediately over the pulp.

Note: It is best to color the fiber red or pink with some stable coloring pigment.

I wish to state here something about the pharmacy of this prescription; for if the preparation does not work satisfactorily, it has not been properly compounded. Arsenic trioxid is the base, cocain is a local anesthetic, and when applied to the pulp produces a condition of analgesia by which the irritating action of the arsenic trioxid is without effect, and thus prevents the tooth from aching while the pulp is being devitalized. With the fatty or oily vehicle, lanolin, it is best to use the alkaloid, cocain, rather than the alkaloidal salt, cocain hydrochlorid; and the less the amount of lanolin used the better will be the action of the base. For this reason largely thymol is added. There is a sufficient amount of water in the lanolin to liquefy the crystals of thymol, therefore it requires but a small amount of lanolin to make a paste out of the arsenic trioxid and cocain.

In those cases where the tooth has ached before the patient presents for treatment, it is always the best practice to allay the pain for at least twenty-four hours before attempting to devitalize the pulp. In any case, whether the tooth has ached or not, before applying the arsenical preparation or before adjusting the rubber dam, it is best to break down all overhanging edges of enamel and carefully remove or wash out with a non-irritating antiseptic solution any food-stuffs or debris which may be in the cavity. Food-stuffs contain albumin, and if such is in the cavity of the tooth when the arsenical preparation is applied, the arsenic trioxid will

act upon the albumin, forming the arsenic albuminate, and thereby a certain amount of the agent is neutralized or becomes inert. As much of the carious dentin should also be removed as can be done without producing pain, for the application should be made to a sensitive spot in the cavity. It is never necessary to have an exposure of the pulp; and in case an exposure exists, it is best to apply the preparation to the dentin immmediately over the pulp, rather than directly to the organ itself. The preparation should be covered with cotton or small metallic or paper disc to prevent pressure and also to prevent the phosphoric acid of the cement from coming in contact with the ingredients of the paste.

There are at least four factors which govern the length of time an arsenical application should remain sealed within a tooth, viz.:

(1) The age and general condition of the patient.
(2) The general condition of the pulp itself.
(3) The amount and condition of the dentin intervening between the pulp proper and the application of the paste.
(4) The climate or season of the year, strange as it may seem, influences the action of arsenic trioxid.

Taking into consideration these various factors, the arsenical preparation should remain in the cavity from one to four days. At the second sitting the rubber dam should be adjusted, the teeth included sterilized, and the cement and paste removed, after which every surface of the cavity should be freshened with a large round bur. This not only insures the thorough removal of the arsenical paste, which, should a portion remain, is liable to produce pericemental inflammation, but it also *mechanically* sterilizes the cavity by removing the carious and infected dentin. This is important and is an aid in *maintaining asepsis* in the removal of the pulp. In the author's judgment this is much better practice than to depend upon a solution of dialysed iron to neutralize the arsenic trioxid.

The pulp chamber can now be opened into and the pulp removed, observing practically the same details as explained under the anesthetization method. Oftentimes in the initial opening into the pulp chamber, and sometimes on entering the canal, after the application of arsenic trioxid, the patient will experience some pain. This condition should be anticipated; for the safest method of devitalizing pulps with arsenic trioxid is to leave the drug sealed in the tooth cavity only sufficiently long to *poison the pulp tissue*—not completely devitalize it; and depend upon the subsequent application of some remedy containing formaldehyd to complete the devitalization. For this purpose the author uses formocresol, which should be left in direct contact with the tissue for about three days, when it can be removed without pain.

In connection with the *preservation of the color of the tooth*, under

the anesthetization method the author stated his objection to the use of hydrogen dioxid for removing the blood from the cavity and canal. It is necessary here also to refer briefly to a well-established practice of treating teeth after the pulps have been devitalized. Heretofore it was the practice of many dentists, after removing the arsenical dressing, to flood the cavity with a solution of dialyzed iron, after which the pulp chamber was opened into, usually producing some hemorrhage; then without any especial effort being made to remove the dialyzed iron or blood, tannic acid in some form was sealed in contact with the pulp for a week or ten days, thinking it advantageous by this means to constringe and toughen the tissue before attempting its removal. Let us consider the rationalism of such treatment. The pulp tissue in all large canals is sufficiently tough to be removed in its entirety, and it must be disorganized or removed piecemeal in small canals, whether it has been previously constringed or not. Hence, there is no advantage in using tannic acid and there is a serious objection. If those who follow this practice are observing, they will notice that after removing the tannic acid dressing, the pulp tissue is dark in appearance. They will also observe that many teeth thus treated subsequently discolor. The cause for this is found in the fact that tannic acid and iron, in any form, are chemically incompatible, the resulting compound being *iron tannate*, one of the most insoluble substances known to chemistry. In the presence of moisture a form of ink is produced which is a great staining agent for dentin, and one that is almost impossible to remove by any known process of bleaching.

As has been stated elsewhere in this chapter, there are cases where, for want of time or other reasons, the pulp can be removed to advantage by devitalization; however, when this method is followed tannic acid should *not* be used, and every trace of dialysed iron (if used at all, and it is unnecessary to use it) and blood should be removed with alcohol or water. In those cases where we are certain that the pulp is all removed and where the canals can be thoroughly dried, the root filling can be inserted at the same sitting, provided there are no symptoms of pericementitis in the apical area. There are many good reasons, however, for not filling the root at this time, some of which have been considered under the anesthetization method.

Complications.—In our discussion thus far of the methods of removing pulps from teeth, we have considered favorable cases, selecting the method best adapted to the case at hand. There are many instances, however, where it is difficult to remove the pulp by either the anesthetization or devitalization method, at least until the tooth is placed in a more favorable condition. Oftentimes in approximating cavities the decay in one or both teeth has extended far beneath the gum, the rough

gingival margin of the cavity acting as a slight irritant by which the gum tissue is stimulated, causing it to proliferate until it fills a portion of, and in some instances the entire, cavity. In such cases the first consideration is to dispose of the hypertrophied tissue. Where the gum fills only a portion of the cavity and the pulp of the tooth is not causing trouble, the cavity should first be enlarged and washed with a warm antiseptic solution, after which it should be dried as well as possible and packed with warm gutta-percha. But in those cases where the gum tissue occupies the entire cavity, and especially where the tooth is aching, it should be removed at once. This is best accomplished by the electric cautery, as it disposes of the tissue, painlessly and without hemorrhage. In the absence of the electric cautery other means must be employed. Hypertrophied gum tissue is quite tough and fibrous, and if it is elevated or pushed back by means of a flat instrument, it will usually be found that the attachment at the gingival margin is small and can easily be severed by employing gum scissors or a lancet, previously dipped in phenol. It is best not to tell the patient what you are going to do, for scarcely any pain will be experienced. The hemorrhage in these cases is usually profuse, but can readily be stopped by cauterization with 95 per cent phenol, a 50 per cent solution of phenolsulphonic acid, or a 15 per cent solution of trichloracetic acid. The blood should now be thoroughly removed, the cavity dried, moistened with eucalyptol and packed with gutta-percha, letting it extend bucally and lingually to fill the interproximal space. The gutta-percha can be removed from the interior of the cavity with a heated flat instrument. Quite often the most practical way of adjusting the rubber dam in these cases is to place the clamp on the tooth posterior to the one thus packed, having a single hole in the dam include both teeth. The packing, if properly placed, filling the embrasure on either side, will prevent leakage. The pulp can now be removed by the method which the operator deems the most feasible.

There is one instance in the removal of pulps from teeth, where students particularly are liable to make a serious mistake if they are not extremely careful. That is in cases where, in large occlusal cavities, especially in lower first molars of children, the pulp has died and the decay has extended through the bifurcation of the roots, leaving rough edges which continually irritate the tissue, causing it to proliferate and ultimately fill the cavity. To carelessly force the anesthetizing solution into such a cavity, where the pulp in the canals is gangrenous, would be the means of causing an acute alveolar abscess. The application of arsenic trioxid would mean the loss of at least one tooth, perhaps one or two on either side of the one to which the application was made, with a portion of the alveolar process.

Before applying either the anesthetizing or devitalizing agent a correct diagnosis should be made, we should ascertain definitely the kind of tissue in the cavity. With a little experience this is usually a simple matter. The history of the case as related by the patient will often serve as a guide. Pulp tissue is generally more sensitive than gum tissue, and when slightly pricked with a sharp instrument bleeds more profusely. If the tissue proves to be hypertrophied gum tissue it is necessary to extract the tooth. In cases where the tissue is hypertrophied pulp tissue it will generally be found unusually resistant to both cocain hydrochlorid and arsenic trioxid, and it is sometimes necessary to resort to cauterization, using the electric cautery if possible, or employing strong escharotics, such as pure phenolsulphonic acid, which is not as painful here as would naturally be supposed, or to the use local anesthetics hypodermically applied, or the administration of such general anesthetics as nitrous oxid and oxygen in order to painlessly remove the tissue.

Quite frequently we find cases where it seems almost impossible to force the anesthetizing solution through the dentin and into the pulp, and when arsenic trioxid is applied it has little or no effect. In these cases we can suspect that the pulp has receded because of some slight but continued external irritation and the space filled in with secondary dentin, the tubuli of which are irregular and do not run at right angles to the base upon which they rest, as in the normal dentin. This condition is more often found in elderly patients. As a result also of external irritation, pulp nodules, calcific bodies of various shapes, are sometimes found within the pulp itself. Many times in removing the pulp in these cases, the most painless and best results are obtained only by a combination of both the anesthetization and devitalization methods; for the removal of these pulp nodules is often a difficult procedure. After we have used cocain hydrochlorid and pressure or previously applied arsenic trioxid and anesthetized or devitalized a portion of the pulp, we may be able to reach the pulp nodule or nodules without producing pain. But frequently these calcific bodies are agglutinated and close the mouth of the canal; especially is this condition found in molar teeth. The pulp tissue immediately under the nodule is extremely sensitive. In such a case the anesthetizing solution could not be forced into the canal without first removing the obstruction, and arsenic trioxid, if applied, would have no effect. These are cases which require much perseverance and patience on the part of both patient and operator. The nodule can sometimes be loosened by gently working around it with an exploring or other suitable instrument. The author has met with success by taking a small round bur and drilling past the nodule, care being taken not to puncture the root, then with the engine running rapidly the nodule is tapped and dislodged. When the

obstruction in the pulp chamber and canals is removed the remaining tissue can be anesthetized or devitalized in the usual manner. If the devitalization method is employed the arsenical preparation can be placed over the mouth of the canal with safety; but it is never advisable to place the preparation down in the canal. Nitrous oxid and oxygen analgesia will prove valuable in these stubborn cases.

Arsenical Poisoning.—Before closing this chapter it may be well to consider the treatment of local poisoning by arsenic trioxid. However, when such treatment is necessary it is due to carelessness on the part of the dentist or the patient, or both. It is never necessary to tell the patient what drug or remedy has been used in the treatment of teeth, many times it is advisable not to do so; but whenever an agent as destructive as arsenic trioxid is sealed within a tooth, the patient should be thoroughly impressed with the importance of keeping an appointment, and of returning before the appointed time should any untoward symptoms develop. The patient should also be informed that the teeth thus treated might ache for a few hours, as they sometimes do, even when cocain is a constituent of the arsenical preparation; but that the aching will be of short duration. In case, however, the tooth or gum becomes sore, they should be instructed to return at once.

In those cases where the arsenical preparation is not hermetically sealed within the tooth and some of it gets on the gum tissue, remaining only long enough to cause devitalization, all that is necessary is to first wash the part with an antiseptic solution, and then mechanically pick off the dead or sloughed tissue with sterile pliers until bleeding is produced, if this is possible, after which the part should be *disinfected* and the tissue *stimulated.* To disinfect the part, any good disinfectant can be used. Nothing is better here than the official 3 per cent solution of hydrogen dioxid. As a means of stimulating the cells, iodin compounds are useful. The Pharmacopeia recognizes a compound solution of iodin (5 per cent) which can be applied by first drying the part. After removing the dead tissue and disinfecting, the author prefers applying euroform paste. A prescription should also be written for an antiseptic mouth wash with which the patient should keep the mouth as clean as possible. The treatment can be repeated as often as the case necessitates; usually one or two treatments will suffice.

In those severe cases where the arsenic trioxid has penetrated to and devitalized the process as well as the gum, the first treatment is surgical. After washing with an antiseptic solution, the affected process should be removed with a suitable bur in the engine. It may be necessary in extensive cases to extract the tooth, after which the treatment is practically the same as has been outlined above. Sometimes there is pain follow-

ing the surgical removal of the affected process. In this case the euroform paste will act as a specific absolutely controlling the pain. The case should be watched closely and the stimulating treatment kept up until the part has healed. The tissue in the interproximal space will never be fully reproduced, and will always be a source of more or less annoyance.

It will be noted that in discussing the treatment of local arsenical poisoning, no mention has been made of dialysed iron. The practice of applying this agent to the affected part is both useless and wrong.

In closing this chapter the author desires to emphasize what was stated in the beginning, that it is the plain duty of every practitioner to study the pathology of the pulp, thus learning to read the clinical symptoms and to save the pulps of teeth in all cases where it can be done with any reasonable degree of success; yet experience and observation will soon show the folly of attempting to save a pulp that has been irritated for any great length of time, and will prove also that in these cases, the safest practice is to remove the pulp and subsequently fill the canal, notwithstanding the difficulty often attending the performance of this operation.

CHAPTER XX

THE TREATMENT OF NON-SEPTIC PERICEMENTITIS

BY J. P. BUCKLEY, PH. G., D. D. S.

General Considerations.—It is not the intention to introduce in these chapters needless pathologic facts, yet in the treatment of pericementitis it is important to remember that the pericemental membrane is very vascular and well supplied with nerves; that it is enclosed within bony walls, and, therefore, when inflammation exists in the tissue the membrane becomes thickened, forcing the tooth from its socket. This elongation of the affected tooth is one of the chief symptoms of true pericementitis.

Before discussing the therapeutics of pericementitis, I desire to indelibly impress upon the mind of the reader the fact that this condition is too frequently produced by carelessness on the part of dentists. It is not always possible to successfully perform dental operations without irritating the susceptible pericemental membrane; however, much of the trouble can be avoided if judgment is exercised and proper precautions are taken in treating teeth.

There are at least two classes of irritants by which non-septic pericementitis is produced, viz.:

(1) Drug irritants.
(2) Mechanical irritants.

The inflammation of the pericemental membrane caused from drug or mechanical irritants, will be called *non-septic pericementitis* in this chapter, in order to differentiate it from *septic pericementitis*—a condition produced by pathogenic bacteria, poisonous ptomains, and irritating gases, which have escaped from a gangrenous root canal.

Drug Irritants.—There are many circumstances and conditions which influence the action of drugs upon different individuals and upon the same individual under different conditions. We find cases occasionally where pulps have been removed by pressure anesthesia, and where, seemingly at least, every precaution was taken in sterilizing the dentin, selecting a sterile anesthetizing solution and in applying the pressure; yet severe apical pericementitis follows. This may or may not be due to the drugs used in performing the operation. There are cases, too, where the pericemental membrane becomes highly inflamed and extremely responsive from

the action of arsenic trioxid, even when the drug was properly sealed within the tooth only a short time. These are conditions over which the operator seems to have no control; however, drugs are often used injudiciously. In the preceding chapter it was stated that an anodyne treatment was indicated after the mechanical or surgical removal of the pulp. Therefore, care should be taken to select drugs for this purpose which produce a soothing and not an irritating effect. There are some instances in dental practice where we desire to irritate and thereby stimulate the pericemental membrane; but this should be avoided here. Judgment should also be exercised in sealing in anodyne remedies, such as phenol, oil of cloves, etc., in the canals, especially in bicuspid and molar teeth, for should the temporary filling be left too full and the remedy forced through the apex by the closing of the jaws, even these agents cease to be anodynes and become irritants. Whether phenol, oil of cloves, and similar drugs or remedies are anodynes or irritants, depends largely, then, on where and how they are used.

In filling root canals it is the practice of many dentists—the author among the number—to moisten the canals with *eucalyptol* before introducing chloro-percha or euca-percha and the gutta-percha cone. Care must be taken here to use eucalyptol and not oil of eucalyptus, unless it be the refined product. Commercial oil of eucalyptus has been the cause of many cases of apical pericementitis following the most careful filling of root canals. The eucalyptus tree produces a volatile oil which contains three constituents, each distilling over at different temperatures; the first product thus obtained is eucalyptol, hence the most volatile constituent of oil of eucalyptus and the one which is the solvent for gutta-percha. While eucalyptol is a slight irritant, it is not nearly so irritating as oil of eucalyptus. The irritating property of eucalyptol can be modified and its antiseptic value increased by adding menthol and thymol in the following proportion:

℞—Mentholis	gr. ij
Thymolis,	gr. iij
Eucalyptolis,	f.℥ j —M.
Sig.—Use as directed.	

This remedy is equally as good a solvent for gutta-percha as is eucalyptol alone; and will be called *eucalyptol compound* in the following chapters.

Mechanical Irritants.—The pericemental membrane is frequently, I might add too frequently, irritated by mechanical irritants, such as root canal fillings, ill-fitting partial plates, crowns and bridges, malleting, regulating, faulty occlusion, salivary and serumal calculus, etc. There is perhaps more pericementitis produced by root canal fillings than by any other mechanical irritant. In filling root canals we should be

absolutely certain that the canal is *aseptic*. If there be any doubt as to this, the operation should be deferred. In a subsequent chapter the author will discuss in detail the technique of filling root canals; however it is well to mention here that care should be taken in filling all large canals so that the filling material may not be forced through the apex of the root; especially should we be careful in filling the canals of teeth after having treated an alveolar abscess. In these cases we must not expect the patient to flinch in filling the root, for there is no live tissue at the immediate end. The apex has been enlarged and it is very easy to force the filling material through into the space where the tissue has been destroyed. While the newly formed tissue which fills the space after proper treatment seems to tolerate this foreign substance without any manifested disturbance, it is best not to have the root-filling material project passed the root end.

A frequent cause of pericementitis is the presence of micro-organisms, which have been introduced through the failure to establish and maintain sepsis in removing the pulp tissue; or pathogenic bacteria, poisonous ptomains and irritating gases that have escaped into the apical area from a gangrenous root canal. This particular kind of pericementitis is known as *septic pericementitis*, and is closely associated with incipient abscess. The nature of the irritants and the treatment of the condition will be fully considered in a subsequent chapter.

Therapeutics.—The first step in the treatment of non-septic pericementitis is to adopt the surgical principle of ascertaining the cause and removing or correcting it, if at all possible. In the earlier stages of pericemental inflammation, it is not always an easy matter to ascertain the *true cause* of the disturbance. For instance, in those cases following the removal of the pulp tissue, it is difficult to know whether the cause is the root filling, the medicine used in the treatment, or whether we failed to establish and maintain asepsis in performing the operation. The author is inclined to believe that it is more frequently the latter than most operators are willing to admit; for certain it is that the more nearly we approach *absolute asepsis* in these operations, the less pericemental trouble we will have. The teeth thus affected are extremely sore, and any remedy can be used in the treatment that will give immediate relief. This is what the patient most desires, and, too often it appears, it is that which the dentist fails to give. Both local and general remedies can be employed. General remedies are more valuable in the treatment of septic pericementitis. If they are used at all in treating non-septic pericementitis, they should be used only in cases where the patient is nervous and has lost considerable sleep. For immediate relief we must depend largely upon the local application of drugs and remedies. In those cases following the removal of the pulp by either the anesthetization or devitalization method, and where the

canals have not been filled, the pain can be relieved almost instantly by the following method: Adjust the rubber dam. If it is necessary to use a clamp, it should be placed on the tooth posterior to the one affected. Sterilize the teeth included in the dam and remove the dressing from the canals. Dehydrate the tooth structure with absolute alcohol. Then wrap cotton loosely around a smooth, sterile broach, dip in oil of cloves or eugenol, and carefully work in each canal. Remove the broach, leaving the cotton. Heat should now be applied to the remedy by means of a hot air instrument or a chip-blower until the cotton becomes dry. Repeat this process several times, after which the same remedy should be carefully sealed within the canal. In doing this, we not only get the benefit of the heat, which is valuable; but the eugenol, the constituent of cloves, is driven into the tooth structure, producing a profound anodyne effect upon the sensitive membrane. The author has succeeded in giving immediate relief by this method of treatment when many others have failed. Grinding the cusps of the tooth where it can be done without injury is advisable; a counterirritant can be applied to the gum and the patient dismissed for several days. It is scarcely necessary to instruct the patient to favor the tooth.

In the treatment of pericementitis following the filling of the root, having every reason for believing that the canals were aseptic, one of the last things the author would suggest doing would be to attempt to remove the root filling. Usually this only serves to further aggravate the condition. These cases can best be traced by counterirritation and general remedies. By counterirritation is meant the application of an irritant to some normal part of the body for the purpose of influencing favorably some other part, usually deep-seated, which is diseased. This irritant is generally applied to the gum over the affected tooth. Capsicum plasters, black mustard papers, cantharidal collodion, all official preparations, are valuable; or the following liniments, which are more generally used, give much relief:

℞—Mentholis,	gr. xx
Chloroformi,	f.ʒ j
Tincturæ aconiti, q. s. ad,	f.ʒ j —M.

Sig.—Dry the gum and apply freely over the affected tooth for several minutes.

This remedy is known as the author's **Dental Liniment.**

℞—Tincturæ aconiti,	f. ʒ ij
Tincturæ iodi,	
Chloroformi,	āā f.ʒ j—M.

Sig.—Make one application to the gum as above.

℞—Liquoris iodi compositæ,	f.ʒ j

Sig.—Use as above.

Inasmuch as tincture of aconite is an important ingredient in many liniments used in the local treatment of pericementitis and facial neu-

ralgia, it is well to remember that the United States Pharmacopeia of 1900 reduced the strength of this preparation from 35 per cent to 10 per cent. Therefore the new tincture can be employed more freely in these cases without danger of poisoning.

As a remedy to be applied by the patient at home, a split raisin, soaked in hot water, and on which is dusted red pepper, can be held on the gum over the affected tooth. A very efficacious remedy is to direct hot water with some force on the part, beginning with warm water and increasing the heat gradually until it is nearly boiling. This must be kept up until we get the full benefit of the heat and resolution promoted. Another good remedy to have the patient employ, is the hot foot bath. The value of this remedy, like the application of hot water to the gums, depends largely upon the manner in which it is done. A deep foot-bath tub should be used and the temperature of the water gradually increased until it is as hot as can be borne. This should be continued from twenty to thirty minutes. Frequently the pain can be relieved by spraying with ethyl chlorid the area over the offending tooth.

There are many other drugs and remedies which can be employed in the local treatment of this condition. Those which have been mentioned here the author has found valuable in his practice. It is far better to have a practical knowledge of a few remedies than superficial knowledge of many. The general remedies to be administered in the treatment of non-septic pericementitis, if found necessary, will be discussed under the treatment of septic pericementitis and incipient abscess in a subsequent chapter.

CHAPTER XXI

THE CHEMISTRY OF PULP DECOMPOSITION

BY J. P. BUCKLEY, PH. G., D. D. S., F. A. C. D.

General Considerations.—The subject of pulp decomposition is one that has commanded the attention of many investigators in our profession, and at the present time the conclusions as to the chemistry of the process are by no means uniform. While this fact is to be regretted, it must be remembered here that there are many difficulties presenting themselves to the student who attempts to study this complicated process from the chemical viewpoint, either for the purpose of outlining a *rational* treatment for the correction of the gangrenous condition, or for the purpose of solving the knotty problems of the discoloration of tooth structure from this source. Until we comprehend more fully the nature of the chemical reactions taking place in the splitting up of the complex bodies of dead pulp tissue and have a more definite knowledge of the intermediate and end-products thus produced, the application of drugs and remedies for the correction of the gangrenous condition and for the restoration of the color of the tooth structure can never be placed upon a rational basis, but must be empirical, as it has been in the past. This is not in accordance with the tendency of the present time. There is a strenuous effort being made in both medicine and dentistry, to rid the professions of much of the empiricism of the past and to place the treatment of all diseased conditions upon a rational basis. With this end in view the author desires in this chapter to direct the reader's attention to the chemistry of pulp decomposition.

It is essential in studying the chemistry of this process to first ascertain the chemical constituents of the original pulp tissue. So far as chemists have been able to determine, practically all of the elements are present in the pulp tissue and its vascular supply that are found in any other animal tissue. These elements are arranged in different compounds which make up the pulp tissue, the proportion of which varies from other tissues, and this, no doubt, accounts for the histologic difference between this and many of the other tissues of the body. However, from a general chemical examination of the pulp tissue we find it analogous, or nearly so, to all other animal tissue. This suggests at once the necessity for the student's

familiarity with the general composition of animal tissue, which will now be considered.

Chemical Composition of Animal Tissue.—There are at the present time about eighty-three elements known to chemistry; but of this number less than seventeen unite, in varying proportions, to form the chemical basis of the animal body. In fact, six elements are about all with which we are concerned in the study of the decomposition of the pulp tissue.

These elements are carbon, C; hydrogen, H; oxygen, O; nitrogen, N; sulphur, S; and iron, Fe.

For convenience in study, the various substances found in animal tissue are divided into two general classes, the classification being based upon the presence or absence of the element *nitrogen*, and are accordingly called nitrogenous and non-nitrogenous substances.

Nitrogenous Substances.—We are taught by physiologists that nitrogenous organic bodies take the chief part in forming the solid tissues, and to an extent are also found in the fluids of the body. *Proteid*, or *albuminous*, substances are the principal nitrogenous compounds, and one or more enter as an essential part into the formation of all living tissue. The elements which constitute the proteid molecule are carbon, hydrogen, oxygen, nitrogen and a small amount of sulphur. Iron and phosphorus are known to exist in the molecule of some proteid bodies. While some chemists have attempted to construct a formula for the molecule, none has been accepted as correct, the opinions of investigators being so varied. To the casual observer it may seem strange that a molecule consisting largely, as it does, of carbon, hydrogen and nitrogen, should have these four simple elements so arranged as to baffle chemists in their effort to construct a rational formula. But this difficulty is readily explained by the fact that of all the elements none differ more widely from each other in their physical and chemical properties than these four. Carbon is a solid substance which exists in nature in three forms: Charcoal, graphite, and diamond, and can scarcely be fused or volatilized. Hydrogen, oxygen, and nitrogen are colorless gases which cannot be solidified by any known means and can be converted into liquids only with difficulty. The three gases also differ in their chemical activity. Hydrogen is combustible; oxygen will not burn, but will support combustion; while nitrogen is perfectly indifferent. Fortunately, too, for nature, in her effort to arrange these elements into a complex molecule, the valency of each differs. Hydrogen is univalent, oxygen bivalent, nitrogen trivalent, and carbon quadrivalent, generally considered. Carbon atoms have also, to a higher degree than the atoms of any other element, the power of combining with each other by means of a portion of the affinity possessed by each atom, thereby increasing the possibilities of the formation of

complex compounds. Thus many atoms of the same element occur in each molecule, which, together with the fact that one of the elements is that peculiar, undecided and indifferent element, nitrogen, aids materially in explaining the reason for the instability of the proteid molecule, or the ease with which under certain conditions it is decomposed.

In order that the reader may be able to follow a theory which the author will advance in a subsequent chapter on the discoloration problem, it is well to remember here that the relative amount of nitrogen compared with sulphur found in the proteid molecule is 15 per cent of the former to 0.3 per cent of the latter.

Non-nitrogenous Substances.—The non-nitrogenous substances consist of *carbohydrates* and *fats*. Several classes of carbohydrates are known to exist, all of which are much less complex than the proteid group; and the arrangement of the atoms in the molecule is much better understood. The carbohydrate molecule is composed of three elements—carbon, hydrogen and oxygen. There are always six (or a multiple of six) atoms of carbon in the molecule, while the hydrogen and oxygen exist in the proportion to form water. These compounds readily undergo the process of fermentation.

Human fats are principally mixtures of palmitin, $C_3H_5(C_{16}H_{31}O)_3O_3$; stearin, $C_3H_5(C_{18}H_{35}O)_3O_3$; and a small amount of olein, $C_3H_5(C_{18}H_{33}O)_3O_3$. As shown by the formula of these compounds, the molecules of each also consist of carbon, hydrogen and oxygen. The proportion of these elements varies in the different compounds. That fats are decomposed or saponified by alkalies, or ferment in an alkaline medium, should be remembered, both in the treatment and the bleaching of teeth.

Thus we have every reason for believing that the pulp tissue, like nearly all living organic tissue, is composed of *proteids*, *carbohydrates*, and *fats;* and on this hypothesis the author will endeavor to ascertain the intermediate and end-products resulting from the decomposition of this tissue when death occurs. Before doing so, however, it may be well that the reader fully understand what is meant by the terms *fermentation* and *putrefaction.* These terms are applied to peculiar kinds of decomposition by which the molecules of certain organic substances are broken up into simpler compounds. The difference between the terms is that fermentation is applied to the decomposition of those substances which belong to the group of carbohydrates, while putrefaction is applied to the decomposition of those substances which properly belong to the proteid group and are classified as nitrogenous substances.

Pulp Decomposition.—The decomposition of the pulp tissue is essentially an analytic process which takes place gradually. Conditions being favorable, the germs present first act upon the complex and unstable

substances composing the original tissue, splitting them up into less complex compounds, many of which are capable of further analysis; and the process goes on until simple and well-known compounds are the result. For convenience in studying this subject the compounds resulting from this analytic process will be arbitrarily divided into two classes, *intermediate* and *end-products;* and it will be seen that it is largely the products of putrefaction rather than of fermentation with which we have to contend in the correction of the gangrenous condition.

Intermediate Products.—The intermediate products depend to an extent upon the character of the micro-organisms in the tissue, but it is safe to say that certain *ptomains* and *amido-acids* are formed.

1. *Ptomains.*—Ptomains are nitrogenous compounds of organic origin, having the reaction and basic property of alkalies. By some authorities they are called *animal alkaloids*, to distinguish them from a similar group of organic bases known as *vegetable alkaloids.*

Among the ptomains liable to be produced are putrescin, $C_2H_{12}N_2$, cadaverin and neuridin, $C_5H_{14}N_2$, the last two named being isomeric as shown by the formula. One of these ptomains, neuridin, is non-poisonous; therefore its presence is of little importance other than to know that it is a nitrogenous base from which ammonia, NH_3, or derivations of ammonia, is evolved by further putrefaction. Still, according to Vaughan and Novy, while pure neuridin is non-poisonous, it possesses a toxic property as long as it is contaminated with other poisonous products of putrefaction. This holds true for all non-poisonous bases. In so far as the correction of the gangrenous condition is concerned, putrescin and cadaverin are perhaps the most important intermediate products known to be formed in the splitting up of the proteid molecule. Like neuridin, they are basic nitrogenous compounds, capable of undergoing further putrefaction, evolving ammonia or derivatives; but unlike this compound, while they were at first regarded as physiologically inactive, both of these bases have been proved by Scheurlen, Grawitz and others to be capable of producing inflammation and suppuration. Therefore, if by instrumentation or otherwise they are forced through the apices of the roots, septic pericementitis or perhaps an acute alveolar abscess will result.

2. *Amido-acids.*—Amido-acids are acids in which hydrogen has been replaced by the univalent radical, NH_2. Among the amido-acids formed in pulp decomposition, in all probability, are tyrosin, $C_6H_4OHC_2H_3(NH_2)CO_2H$, and leucin, $C_5H_{10}NH_2CO_2H$. These substances, wherever found, have practically the same physiologic properties and pathologic significance. They occur in the intestine during the digestion of proteids, and leucin is found in almost every cell of the animal body.*

* Simon's "Manual of Chemistry."

Pathologically, they are found in atheromatous cysts, in pus, abscesses, etc., as well as in a gangrenous root canal. It is well to remember here that these intermediate products are also nitrogenous compounds from which ammonia, or derivatives of ammonia, is evolved by further putrefaction, and that *fats are one of the end-products.*

End-products.—The chief end-products of pulp decomposition, as has been known for a long time, are water, H_2O; carbon dioxid, CO_2; acetic acid, $HC_2H_3O_2$; ammonia, NH_3; hydrogen sulphid, H_2S; and a semi-putrid substance consisting largely of fats, depending upon the extent to which the putrefactive process has progressed.

Simultaneously with the decomposition of the pulp tissue proper, the dentinal fibrillæ are broken up, as is also the hemoglobin and other constituents of the blood; and the tubuli as well as the pulp chamber and root canals are filled with the intermediate and end-products of the decomposition.

The principal gases generated by the putrefaction of the proteid substances, the main constituent of the original pulp tissue, are *ammonia* and *hydrogen sulphid.* Now, it is interesting and important to know which of these two gases is evolved in the greater quantity. This is easily estimated when we recall the relative amount of nitrogen and sulphur found in the proteid molecule. As previously stated, there is approximately 15 per cent of the nitrogen to 0.3 per cent of sulphur. Hence, ammonia is evolved in the greater quantity. It is quite evident, then, that hydrogen sulphid is not generated in a gangrenous root canal in such quantities as has been so generally supposed; yet this compound is a constant end-product and is important, because it is an *acid* gas, with a disagreeable odor, having local irritating properties; and also because of the part it plays in the discoloration of the tooth structure. The author desires to state here, however, that while he realizes hydrogen sulphid is an active chemical agent, in his opinion it has been greatly over-estimated in the role it assumes in the discoloration of teeth from pulp decomposition as will be shown in a subsequent chapter.

In our study thus far of the chemistry of the complicated process of pulp decomposition, we have learned something of the nature of the intermediate and end-products resulting therefrom, and now it is possible for us to select, with some intelligence, drugs and remedies which will not only destroy bacteria, but will also act chemically upon these noxious products, converting them into non-infectious and non-toxic compounds.

CHAPTER XXII

THE TREATMENT OF GANGRENOUS PULPS—ACUTE AND CHRONIC ALVEOLAR ABSCESS, WITH COMPLICATIONS; AND THE FILLING OF ROOT CANALS

BY J. P. BUCKLEY, PH. G., D. D. S., F. A. C. D.

General Considerations.—The treatment of gangrenous pulps and their sequelæ in the past, has, to a great extent, been purely empirical. The reason for this can be found in the apparent lack of interest which generally has been shown in the chemistry of pulp decomposition. A knowledge of the changes wrought in the splitting up of the complex bodies of the dental pulp by micro-organisms is of vital interest to every practicing dentist; and every student should therefore familiarize himself with this important subject. The only method by which drugs and remedies can be scientifically applied to the treatment of the conditions under consideration is to have a definite knowledge of the intermediate and end-products resulting from the putrefactive process as outlined in the preceding chapter.

Every practitioner of dentistry knew from sad, past experience that in the process of pulp decomposition, some kind of mephitic gases were evolved which if confined would produce severe pathologic disturbances; but just what the gases were and how the unfavorable conditions were brought about we were left to conjecture. From our study of the chemistry of pulp decomposition we have every reason for believing that the main gases produced are *ammonia* and *hydrogen sulphid*. When these gases are generated and cannot readily escape through a cavity, pressure is produced, thereby forcing micro-organisms and their poisonous ptomains through the apices of the roots into the surrounding tissue from which infection, septic pericementitis and in many instances an alveolar abscess result.

There has been much discussion in the dental literature of the past in regard to the penetrating or non-penetrating power of coagulating agents in gangrenous root canals. It is true, as claimed by some authorities, that such drugs as phenol, creosote, solutions of zinc chlorid, etc., are contraindicated in the treatment of gangrenous pulps, but not because

they possess the coagulating property; for when the dental pulp is undergoing or has undergone the process of decomposition, the proteid constituents or coagulable substances have lost their former identity, and new compounds with entirely different properties have been formed. In selecting drugs to be used in the treatment of this condition, the author will therefore eliminate the question of coagulation and will select drugs, which, if properly used, will unite chemically with the intermediate and end-products of decomposition, converting them into odorless and non-infectious compounds, as well as destroy germ life. In this connection it should be remembered that the gangrenous condition has been brought about through the agency of micro-organisms by a gradual analytic process, and among the products formed which must be considered in the treatment are *hydrogen sulphid*, the *poisonous ptomains* (putrescin and cadaverin), and *ammonia* or derivatives, the latter gas being evolved from the further putrefaction of the last named compounds, or compounds of similar composition. It is well to remember also that *fats* or fatty acids are a class of end-products resulting from the putrefaction of proteid substances.

The main gases formed, then, are ammonia and hydrogen sulphid. Now it will be necessary to dispose of these gases in order to hermetically seal the cavity, an object the accomplishment of which is much desired in the treatment of these cases; for by so doing we prevent the oral fluids from contaminating the medicine within the tooth, the medicine from escaping into the patient's mouth, and the tooth from changing color during the time of treatment.

It has been known for some time that *formaldehyd* (CH_2O), a gas which occurs in commerce in a 37 per cent aqueous solution and which solution is recognized by the United States Pharmacopeia of 1900 and 1910 under the name of liquor formaldehyd, or formalin, will unite with ammonia, producing urotropin, a solid, as $6CH_2O + 4NH_3 = (CH_2)_6N_4 + 6H_2O$.

Formaldehyd unites also with hydrogen sulphid, forming, in the author's opinion, methyl alcohol, a liquid, and sulphur, a solid, as $2CH_2O + 2HS = 2CH_3OH + S_2$.

It is stated on good authority that this same gas, formaldehyd, unites with basic ptomains, forming inodorous compounds. By the use of formaldehyd, then the *irritating gases* and *poisonous liquids* (largely ptomains) can be changed chemically into *non-irritating* and *non-poisonous liquids* and *solids*. The official solution of formaldehyd, however, is too irritating for general use; therefore, inasmuch as fats result from pulp decomposition and are present as such in a gangrenous root canal, the author selected *cresol* as an agent with which to dilute the official

solution and thereby modify the irritating action of formaldehyd. Cresol is now also recognized by the United States Pharmacopeia of 1900 and 1910 under this name. Formerly the product was commercially called *tricresol*. This agent has a tendency to darken when exposed to light. It is recommended that a clear solution be obtained and then kept in an amber colored bottle.

Liquor formaldehyd can be diluted with such other agents as phenol, or creosote, if, in the latter instance, a small amount of alcohol is added to clear the solution. Cresol, however, is recommended for four principal reasons:

1. It is miscible with the liquor formaldehyd in all proportions, thus making, without the addition of alcohol, a good pharmacal product from which formaldehyd gas is constantly generated.

2. It is a good disinfectant, much more powerful than phenol.

3. It possesses an anodyne property which modifies the irritating action of formaldehyd.

4. It acts chemically upon the fatty compounds thereby disposing to advantage of these substances.

Treatment.—In the successful treatment of the conditions under consideration there are three important factors which must be accomplished:

1. Establish asepsis.
2. Prevent recurring sepsis.
3. Preserve or restore the color of the tooth.

I. *Gangrenous Pulps.*—In calling the attention of the reader to a method of treating this condition, which has proved very successful in the author's practice, I desire to emphasize the necessity for observing the details of the method. Our first duty here, as in all treatment cases, is to make a correct diagnosis, after which the rubber dam should be adjusted in every case where it is possible to do so, and all the teeth included, sterilized. For this purpose either a 10 per cent solution of formaldehyd to which a small amount of borax has been added, or a 1–500 solution of mercury bichlorid in cinnamon water can be used. After using one of these solutions the teeth are bathed in alcohol, when, with a suitable round bur, the pulp chamber is freely opened, exposing all of the canals, but making no attempt to remove the contents therein at this sitting. Now, on a small pledget of cotton the following remedy is placed in the pulp chamber and over the mouth of each canal.

Original Formula

℞—Cresolis,
Liquoris formaldehydi, āā f℥j—M.
Sig.—Use as directed.

For convenience this remedy will be called *formocresol*. It is always best to seal the cavity with a quick-setting cement, for the remedy should be *hermetically sealed and pressure must be avoided*. To prevent the cement from filling the entire cavity and also to facilitate its subsequent removal, metallic or paper discs or even cotton can be placed over the remedy, filling most of the cavity, when only a veneer of cement is necessary to hermetically seal it. This dressing can remain until you wish to have the patient return for a subsequent sitting. The author prefers to leave it about two or three days. However, it can be safely changed the following day, and no harm follow if it remains a week or more. At the second sitting, the rubber dam should be adjusted, the teeth included sterilized, and the dressing removed, after which the canals should be mechanically cleaned with a proper broach, exercising the same judgment here in the selection of the broach as was emphasized in a previous chapter. If there be any odor in the canals characteristic of putrescence, or if effervescence is produced by testing with a solution of hydrogen dioxid, the canals should be dehydrated with alcohol and warm air as thoroughly as possible and formocresol again placed on cotton, this time loosely in each canal, and the cavity hermetically sealed.

In those cases, where, at the second sitting, there is no evidence of putrescence, which will be found to be the condition generally if the first treatment is properly employed, the original formula can be modified and used. It is not necessary or advisable, however, to keep a modified formula prepared. It can readily be made at the time by taking two minims of the original formula on a clean watch crystal, and adding to this one or two minims of cresol as thought best by the operator at the time. This dressing should remain for at least three days, by which time the remedy will have sterilized the entire tubular structure of the dentin, thus *establishing asepsis*. All that is necessary now to *prevent recurring sepsis* is to thoroughly fill the canals. This remedy will not discolor tooth structure and the fact that it not only can but should be *hermetically sealedin the cavity*, will prevent discoloration by the ingress of the fluids of the mouth. In case the color of the tooth crown was lost before undertaking the treatment and being desirous of preserving the tooth by an inlay or filling, the *color can be restored* by one or two applications of sodium dioxid, Na_2O_2, or by sealing a 25 per cent ethereal solution of hydrogen dioxid (pyrozone) in the cavity for twenty-four or forty-eight hours. The use of sodium dioxid will be explained in a subsequent chapter on bleaching teeth.

Complications.—1. *Badly Decayed Root.*—This formocresol is very destructive to the soft tissues of the mouth, therefore the importance of always adjusting the rubber dam. If this cannot be done on account

of a badly decayed root, it is suggested that care be taken in sealing the remedy in the cavity at the first sitting, and, in placing the cement, the original outline of the root can be approximated. After the cement has set, a band or matrix of gold or German silver can be fitted to and cemented on the root. In treating the case where there is a tooth posterior, it is best to place the clamp on this tooth and gently stretch the rubber over the band and thereby avoid loosening it unless there is some exceptional reason for saving a badly decayed root, it should be extracted; but in case the *X*-ray and judgment of the dentist favors the retention of such a root, it can be treated as here outlined.

2. *Pulp Partially Alive.*—In those cases where the pulp tissue is gangrenous in one or more canals of a multirooted tooth and alive in the other one or two canals, as the case may be, we will find much satisfaction in using the formocresol remedy. These are exceptional cases and it is difficult to know whether this condition exists until the second sitting. If there be much vitality in the live pulp tissue, the formaldehyd in the remedy will doubtless make the tooth ache, but after we know the conditions our method of procedure is simple and the results will be certain. A small pledget of cotton dipped in the remedy can be gently placed over the mouth of the canals which contain gangrenous material, and a thin quick-setting cement flowed over the cotton. After the cement has set the live pulp tissue in the remaining canals can be anesthetized or devitalized as the operator deems best at the time. Formerly these were difficult cases to treat, but with a remedy which can be hermetically sealed in a gangrenous root canal, the procedure is materially simplified.

The author realizes that the method of treating gangrenous pulps, here given, is a radical departure from those generally advocated; and, like myself at first, some of my experienced readers may hesitate to hermetically seal a cavity in a tooth which contains a gangrenous pulp. The reason this could not be done in the past by the methods in vogue, is that drugs, in most instances, were selected and used solely because of their ability to inhibit the growth or destroy the vitality of microorganisms. The fact that there other things, such as irritating gases, and poisonous ptomains, found in the canal and tubular structure of the dentin, and also the further fact that it was as necessary to dispose of these substances as it was to destroy germ life, was not given the significance this phase of the subject merited. The treatment which is here outlined is along rational lines, for the remedy chemically converts the noxious intermediate and end-products of pulp decomposition into substances which themselves possess antiseptic and disinfectant properties.

II. *Acute Alveolar Abscess.*—The treatment of septic pericementitis and acute alveolar abscess, as was intimated in the chapter on The Treat-

ment of Pericementitis, is so nearly identical that they will be discussed here conjointly. In those cases where the patient did not present for treatment until the confined gases had escaped through the end of the root, carrying the micro-organisms and poisonous ptomains into the surrounding tissue, it is our duty to try to aid nature in aborting an abscess. It is in these cases that good judgment must be exercised, and extreme care taken. There is no condition which we are called upon to treat wherein a practical knowledge of pathology and therapeutics will serve us better than in this particular case. Frequently patients delay coming to the dentist until the infection has progressed to a point where all remedies will fail in aborting an abscess; but in many instances this result may be prevented by the proper use of drugs. The local treatment here is exactly the same as above for an ordinary gangrenous pulp; for you never have a case of septic pericementitis or incipient abscess unless the pulp is dead and has undergone, partially at least, the process of decomposition. However, if the tooth is extremely sore, as is usually the case, the patient need not be subjected at this sitting to the annoyance of adjusting the rubber dam. Keep the tooth just as dry as possible, open into the pulp chamber, holding the tooth by some means while drilling, so that the jarring will not further irritate the condition; then carefully seal in the formocresol remedy with cement; after which our attention, if necessary, should be given to the treatment of the infected pericemental membrane. In order to control the infection, and at the same time aid nature in readjusting the abnormal condition; it is not only our privilege, but it is our duty in these severe cases to administer internal drugs. Here alterative drugs are indicated. The great representative of the alterative class is potassium iodid, which can be given in the following prescription:

℞—Potassii iodidi, ʒ jss
Syrupi sarsaparillæ comp., f℥ iij—M.
Sig.—Take a teaspoonful in water after meals.

Ordinarily the directions would be as given, to have the patient take a teaspoonful three times a day after meals; but in these cases of septic pericementitis or incipient abscess it is best to direct the patient to take a teaspoonful every two hours until three or four doses are taken, and then follow the directions written on the label. It is well also to avoid the accumulation of blood in the part. To prevent this, saline cathartics are indicated—one that can be given is the official solution of magnesium citrate, owing to the facility with which it can be taken and its acceptability to the stomach, a prescription for which follows:

℞—Liquoris magnesii citratis, f℥ xij
Sig.—Take one-half at once and the other half in two hours, if necessary.

An effervescent magnesium citrate is now prepared by pharmaceutical houses, and this here will be found useful. Magnesium sulphate (Epsom salts) is also an excellent remedy to be used for this latter purpose. The patient can be directed to take a teaspoonful dissolved in a wine-glassful of warm water, having a glass of cold drinking water at hand to drink at once after taking the strong salt solution. The cold water removes at once the bitter and unpleasant taste of the salt. A very good remedy to have the patient employ at home is the hot foot bath as explained in the chapter on The Treatment of Pericementitis. In malarial regions and in the spring of the year in many localities, the salts of quinin can be given, with beneficial results. The salt which the author prefers giving, if indicated in the conditions under consideration, is quinin bisulphate. Nearly all pharmacies have the salts of quinin put up in the form of pills. While these pills may be given it is much better to write a prescription for capsules. The gelatin capsule is soon dissolved in the stomach; thus we obtain the action of the drug more rapidly than when given in the dry, hard, pilular form. The following prescription can be written for the drug in two grain doses:

℞—Quininæ bisulphatis, gr. xxiv
Ft. capsulæ No. 12.
Sig—Take one capsule every hour until the effect become noticeable.

Quinin acts differently upon different individuals. Most adult patients know the effect of this drug upon their system and therefore will be able to aid the dentist in determining the amount to be taken in a given case.

One of the most prominent symptoms with which we have to contend here is *pain*. In most cases the pain will subside soon after the local treatment; however, it is necessary occasionally, where the patient is nervous and has lost considerable sleep, to administer drugs which act upon the central nervous system, thereby controlling the pain. There are several drugs which if properly given will produce the desired effect. The United States Pharmacopeia of 1900 and 1910 recognizes a compound powder of acetanilid which is recommended and can be prescribed as follows:

℞—Pulveris acetanilidi comp. gr. xij
Ft. chartulæ No. 2.
Sig.—Take one powder at once and the other in two hours, if not relieved.

Another very useful prescription for acetanilid is one suggested by the late Dr. A. W. Harlan.

℞—Acetanilidi, gr. viij
Syrupi simplex, f℥ ss
Spiritus frumenti, q. s. ad. f℥ iij—M.
Sig.—Take one-half at once and the remainder in two hours, if not relieved.

Dr. J. E. Keefe, of Chicago, suggests the following remedy by which he claims instantaneous and often permanent relief can be obtained:

℞—Alcoholis,
Aquæ, āā f℥ j—M.
Sig.—Use as directed.

This remedy is best administered in the form of a spray, using a watch case atomizer for liquids, forcing the spray well back into the nostril on whichever side the affected tooth is located. The application can be repeated as often as is necessary without any ill effects. In case an atomizer of any kind is not at hand, about fifteen minims of the remedy can be placed far back in the nostril with a suitable syringe.

The author does not wish to be understood as suggesting these various internal remedies in all cases of acute abscess. No therapeutist can tell exactly what internal drugs he would suggest without seeing the case and knowing the history; for there are many circumstances and conditions which modify the effect of drugs. Every remedy here mentioned, however, will be found useful in certain cases.

III. *Chronic Alveolar Abscess.*—There are two varieties of chronic alveolar abscesses—those without an external opening, except perhaps through a cavity in the offending tooth, and those which are discharging through a sinus. In these cases the decomposition of the pulp tissue is complete; the intermediate products (ptomains and amido-acids) have largely been broken up, and pus has been formed from the tissue and fluids surrounding the ends of the roots.

1. *Abscess without Sinus.*—In treating that variety of alveolar abscess or the so-called dental granuloma which is without an external opening, our method of procedure is somewhat different. The tooth should be located; the rubber dam adjusted, and the teeth sterilized as before; then the pulp chamber is opened with a suitable round bur. Usually in the case of an abscess proper the pus flows freely, in which case it is permitted to do so, pressure being made on the tissue immediately over the end of the root. It should be our effort to mechanically evacuate as much pus at each sitting as is possible. This being done, we have no necessity for using formaldehyd in the same strength solution as in those cases where the pulp chambers, root canals, and tubuli are filled with the intermediate and end-products. The modified formocresol remedy will be useful here. The canals should be dried with alcohol as thoroughly as possible and the remedy on cotton hermetically sealed in each canal. It is, however, at this sitting, impossible to get the canals dry, and it is unnecessary to have them so, for the remedy will penetrate where moisture is present. This is an advantage over most remedies suggested for this purpose. In those cases where there is a copious flow of pus at the first sitting, the original

formula can be used, and the dressing should be changed every day until it can be removed without the pus flowing from the canals. When pus is forming rapidly at the end of the roots, the dressing soon becomes dissipated, the remedy is neutralized, and it is a loss of time to leave it in the canals more than twenty-four hours. Unless there be some complication, the pus formation should be checked in one or two treatments; at which time the modified formocresol remedy can again be used. It is now possible to change the dressing too often. The formation of pus has been checked, and the tooth should not be disturbed for at least one week or ten days, in order to give nature a chance to effect a cure. If at the end of this time there is no evidence of pus and the case gives a favorable history, the canals can be filled. Should there, however, be a slight odor although the tooth has not caused any trouble, we are not justified in filling the root. In these cases phenol compound can be substituted for formocresol and used with gratifying results. It should be remembered that the value of formaldehyd in any remedy to be used in the treatment of these conditions depends upon the power this agent has of uniting chemically with hydrogen sulphid, ammonia and poisonous ptomains. When these substances are not present, formaldehyd, especially in this strength solution, is contraindicated. This precaution is mentioned here because formaldehyd is na irritating gas and any remedy containing it should be modified according to the conditions as found.

Quite frequently in these alveolar abscess cases, after the formation of pus has been checked we have a weeping of serum from the canals. An excellent remedy to use in this case is eucalyptol to which thymol has been added in the following proportion:

℞—Thymolis, gr. x
Eucalyptolis, f ʒj—M.
Sig.—Dry the canal as much as possible and hermetically seal in the remedy.

If this remedy fails to check the secretion and the fluid is *serum* not pus, no hesitancy need be felt as to filling the root, although the canals cannot be dried.

Occasionally we find a chronic alveolar abscess of this variety where it is almost impossible to check the formation of pus by applying drugs to the canals of the teeth. In such cases the radiogram will aid materially in determining the area involved. In those canals where the pus continues to flow freely when the dressing is removed at the third or fourth sitting, some complication can be expected. It is necessary then to force some stimulating agent through the apices of the roots, after the pus has been mechanically evacuated. The stimulating agent which the author uses almost invariably is a 59 per cent solution of phenol-

sulphonic acid. In resorting to this means of bringing about a more acute condition, I desire to emphasize the necessity of first evacuating the pus as completely as possible before using the remedy, after which the agent should be gently forced through the apices and the modified formocresol remedy sealed in the canal. It will be found that one or two treatments will usually check the formation of pus, after which the case can be treated as an ordinary abscess of this kind. In case this method fails to effect a cure, however, it will be necessary to either extract the tooth or surgically establish an opening through the overlying process and soft tissue and treat as for an ordinary discharging abscess—which treatment will now be considered.

2. *Abscess with Sinus.*—In those cases where the pus is discharging into the mouth through a sinus, our first duty is to locate the offending tooth. This is generally a simple matter for the reason that the sinus usually opens immediately over the tooth from which it comes. The pus in making its exit, however, follows the line of least resistance, and in some cases the condition of the process is such that the pus burrows forward or backward, and opens through the gum at a point several teeth removed from the one which is causing the trouble. These are the cases that are difficult to diagnose, especially where the abscess has been discharging for some time, when there is not much tenderness in any special tooth, and where there are several pulpless teeth on this side of the mouth. Sometimes two teeth containing gangrenous pulps have a common sinus. In this case it would be impossible to heal the tract by treating only one of the teeth. The radiogram is the best means at our command for determining the tooth or teeth involved. In the absence of the X-ray the silver probe will be found valuable. By gently working the probe forward or backward the sinus can be explored and the offending tooth or teeth located without drilling into innocent teeth—a discouraging procedure to both patient and dentist. The tooth being located, all that is necessary to effect a cure—there being no complication—is to force some bland solution through the root canal and sinus, thus being certain it is well established; cauterize the tract, hermetically seal in the canal or canals the same agent used for this latter purpose or the modified formocresol remedy, and, at the subsequent sitting, the case giving a favorable history, fill the root.

Establishing Sinus.—If the abscess is not discharging, and it is well in those cases where it is discharging, before adjusting the rubber dam, to enlarge the mouth of the sinus with a lancet or bistoury. By dipping the lancet in phenol, this may be accomplished with very little pain to the patient. After this is done the rubber dam should be adjusted and the canals freely exposed. Now that the infection is past the end

of the root, we need not hesitate to mechanically clean the canal at this sitting. The canals being clean we are ready to establish the sinus. To do this we need a bland solution and a good hypodermic syringe with a long straight needle for anterior and a long curved needle, for posterior teeth. There is an advantage in having a long needle, for the nearer the point is to the apex of the root, the less packing and force is required to send the solution through the sinus. Any bland solution can be used for this purpose. The author suggests peppermint water to which two minims of phenol has been added to the fluid ounce. Physiologic salt solution is also good. A piece of unvulcanized rubber of the proper size should be selected, softened in the flame, and a hole made in the center through which the needle is placed and inserted into the canal. The rubber should now be tightly packed around the needle and held on either side with flat nose pliers, when pressure can be made on the piston of the syringe and the solution forced through the sinus. This should be repeated several times, care being taken not to break the needle in the canal. If convenient one corner of the dam can be raised, exposing the mouth of the sinus to view. There are two objects in forcing a bland solution through the sinus: one is to be certain that it is open, and the other is to mechanically wash out the pus. Whenever pus can be mechanically removed, it is always better to dispose of it by this means rather than to do so by the use of some chemical agent. Formerly it is common practice after the sinus is established to use a solution of hydrogen dioxid. This is often a dangerous procedure and *always unnecessary* if the first solution has been used in sufficient quantity. For cauterizing the sinus in simple cases 95 per cent phenol has been largely employed. An excellent preparation to use for this purpose is phenol compound or phenolsulphonic acid. With the sinus well established, it is never necessary to place either of these solutions in a hypodermic syringe. The author knows of several instances where this has been tried with disastrous results. The remedy can be applied to the canals on cotton, when, with unvulcanized rubber and a suitable instrument, it can be forced through the sinus. Alcohol is a positive antidote for phenol; the alcohol bottle should therefore be in a convenient place so that the remedy used in the canal can be neutralized at once when it appears at the mouth of the sinus. If this has been well done, it matters little what drug or remedy is sealed in the canal. The phenol compound or the modified formocresol solution will give excellent results if hermetically sealed in the canals for about one week. In cases of long standing when we can reasonably suspect a roughening of the end of the root or process through which the pus has been discharging, and where the X-ray findings are unfavorable, the tooth should be extracted. The author

does not believe in delaying the root filling long after the sinus has been cauterized in uncomplicated cases; for by filling the root as soon as we are certain that the sinus is healing, we avoid a weeping condition, which usually exists and which is annoying when this part of the treatment is delayed for one month or six weeks as advocated by some writers. In these cases where the first treatment has been thorough, and the case gives a favorable history, the root should be filled at the second, or, at most, at the third sitting. If the case does not yield to the above treatment, some complication may be expected.

It is sometimes difficult to establish the sinus, especially on molar teeth. In all such cases where there is no complication, the case can be nicely treated with the formocresol solution as outlined under treatment of abscess without sinus. Before referring to complicated cases, the treatment of gangrenous pulps and abscesses associated with deciduous teeth will be considered.

Treatment of Gangrenous Pulps and Abscesses in Deciduous Teeth.—In treating the conditions under consideration, in the mouths of children, it is necessary in most cases to modify our usual method of treatment. Our first duty here is to gain the confidence of the child. If the abscess is associated with a deciduous molar which we would desire to save for at least a year or two, it can be treated nicely in the following manner: After gaining the confidence of the little patient the mouth can be rinsed with an antiseptic solution—one which has a pleasant taste. Then open into the pulp chamber and place a pledget of cotton in the opening. Now mix on one end of the cement slab thymolized calcium phosphate and the formocresol remedy, making a stiff paste. On the other end of the slab have a quick setting cement ready to mix. Again rinse the patient's mouth and, keeping the cavity as dry as possible, gently pack the paste into the pulp chamber and flow the cement over it, filling the cavity. If deemed advisable, the cavity can be prepared in the cement and filled with amalgam. It is remarkable how rapidly these abscesses will heal and remain quiet when treated in this manner, provided, of course, there be no caries or necrosis of bone.

Complications.—There are several complications of chronic alveolar abscess of both varieties, with and without a sinus, where it is necessary to modify or change the general method of treatment to meet the conditions as they exist. For instance, in the case of an abscess without a sinus where we can reasonably suspect, and where the indications point to a roughening of the end of the root, we ought not to expect to cure the case by simply sealing remedies within the canals of the tooth. If we do, we are expecting too much of drugs. Again, in a case of an abscess with a sinus where the pus has been discharging for several months, with the not

unusual result that the end of the root or process through which the pus has discharged has become roughened, we should not expect to effect a cure by forcing phenol or phenol compound through the sinus; because such agents as these have no action whatever on the bony structures.

1. *Denuded End of Root.*—One complication we may expect to find in abscesses of long standing, especially in the variety without a sinus, is where a large area of tissue in the apical space has been absorbed or broken down, denuding the end of the root and the denuded portion projecting into the absorbed area. It is possible, in these cases, to make pressure over the end of the root and mechanically evacuate all of the pus above the apices; but we cannot expect by this means to evacuate the pus below and surrounding the end of the root projecting into the space. In this case we should extract the tooth.

2. *Resorbed Root.*—Another complication of both varieties of chronic alveolar abscess is where the pus has stood in contact with the end of the root sufficiently long to cause resorption, leaving a roughened end which irritates the tissue and prevents healing. Sometimes, also, the process through which the pus has burrowed is left with sharp edges. In all such complications the tooth should be removed.

3. *Encystment of Root.*—A difficult complication to treat is where an abscess occurs on a root, the end of which has become encysted from deposits, excementosis or other causes. In order to effect a cure in these cases, it is necessary to establish a sinus and remove the deposits, excise the root-end, or extract the tooth. The method of excising the root-end will be discussed later.

4. *Involving Vault.*—Still another complication often difficult to cure is where the pus has worked its way through the lingual plate of bone and involves the vault of the mouth. The dense fibrous tissue covering the vault is very tough and the pus often separates the periosteum from a considerable area of bone before ultimately discharging into the mouth. Generally a lancet is required to evacuate the pus. In treating these conditions it is essential to explore the affected area, using a sharp steel instrument in order to determine whether there is caries or necrosis. Unless too much bone is involved the case can be successfully treated by first making a liberal opening with a sharp bistoury and, if necessary, breaking down the sharp edges of bone, through which the pus has borrowed, with a round bur having a long shank, after which the sinus should be established in the usual manner, using a considerable quantity of the bland solution. Now dry the cannal and force through the sinus full strength phenolsulphonic acid. Sometimes it is advisable to place a piece of blotting paper soaked in liquid petroleum over the lingual opening when forcing the acid through. This causes the agent to spread and come in contact with the

entire area involved. Alcohol and the oils will neutralize any excess of the phenolsulphonic acid that may get on the other tissues of the mouth. This treatment should be repeated as often as the case demands. When there is no evidence of pus and the case has healed sufficiently so that there is only a watery discharge the root can be filled.

5. *Secondary Abscess Pocket.*—Occasionally we find an abscess of the discharging variety which does not yield to our general treatment, yet we are reasonably certain that none of the complications so far mentioned are present. In these cases we can suspect a *secondary abscess pocket.* This is especially true where the sinus opened into the mouth several teeth removed from the affected tooth. This pocket can usually be discovered by the aid of the X-ray or a small silver probe. The treatment is simple—all that is necessary is to open the pocket, wash it out first with a bland solution, then inject 50 per cent phenolsulphonic acid. In using phenolsulphonic acid in such cases it cannot be injected through the tooth, therefore it is necessary to use a syringe—a glass syringe with an asbestos-packed plunger and a gold or a platinum needle should be used.

6. *Involving Antrum.*—The pus in making its exit follows the line of least resistance, and sometimes it is easier to work its way through the floor of the antrum than through the labial or lingual plate of bone. The treatment of this complication will not be discussed here; but in this connection it is well to remember that so good an authority as Kyle, viewing the question from the nasal side, finds that fully 50 per cent of antral diseases are of dental origin.

Excision of Root-end.—In all complicated abscesses which will not yield to the treatment outlined above, we can often save the root by excising its end. This should be done only as a last resort and then under the most aseptic measures. The hands of the operator, as well as all instruments used, should be thoroughly sterilized. Before operating, the root should be filled and a thorough exploration made that the amount of process and root involved may be noted. A local anesthetic injected deeply should be employed and an incision should be made. If only one tooth is involved the author prefers following the general method of Dr. M. I. Shamberg, of New York. The incision is made immediately over and parallel with the affected root. With a periosteotome the tissues are deflected on either side of the incision and held back by the author's tissue retractor. We now have the root-end exposed to view, when it can be excised or burred off as is indicated. After removing the excised end, the root remaining should be smoothed with a round bur and the area thoroughly curetted, removing any necrosed process which may be present. The wound should now be washed with an antiseptic solution and packed with sterile gauze. The patient should be instructed to keep the mouth as

clean as possible and the packing should be changed every two days until granulation begins to fill the space. For a more detailed description of the surgery of chronic alveolar abscess see the author's work on Dental Therapeutics.

In all these complications it should be remembered that *no tooth should be retained in the mouth which harbors infection;* and unless the infection can be removed by treatment and bone regeneration result, the offending tooth should be extracted and such surgery performed as the experienced operator deems necessary. Whenever the operator is in doubt as to the best means of treating complicated alveolar abscesses, he should never hesitate to consult with a practitioner who has had more experience in treating these cases. Such a course cannot be construed as a lack of knowledge, but is evidence of conservatism and progress.

Pericemental Abscess.—All of the alveolar abscesses which we have discussed thus far in this chapter have been the result of an infection in the apical area, the infection being due to pathogenic bacteria, poisonous ptomains and irritating gases, which have escaped from a gangrenous canal. There is, however, an abscess that occurs in the alveolar region about the roots of teeth, not caused from the source mentioned. This particular kind of abscess occurs in connection with live teeth; not necessarily so, however. There is a progressive breaking down of the pericemental membrane and in dental literature it is called a *pericemental abscess.* The cause of this particular kind of abscess is rather vague; but it is generally supposed to be due to some traumatic injury. It frequently occurs on the labial surface of the roots of the anterior teeth involving most of this surface. They have also been known to occur between the roots of molar teeth, especially the upper molars. While a pericemental abscess is often associated with pyorrhea alveolaris, care should be exercised, in making the diagnosis, not to get this condition confused with the latter disease.

Treatment.—For convenience in outlining our treatment for a pericemental abscess, the condition may be classified as *acute* and *chronic.* As a rule there is very little pain associated with either variety of pericemental abscess. In the acute form, which, as such, is extremely difficult to diagnose, the patient will complain of "something being wrong with a particular tooth." About all that can be done therapeutically with the acute form is to pacify the patient as best we can until the acute abscess develops into the chronic variety when pus is formed and discharges usually at the gum margin, and thus the diagnosis is more easily made. If the abscess occurs on the anterior teeth where the area involved can be curetted and cauterized it will generally yield to the treatment; but the treatment of a chronic pericemental abscess on molar teeth is at best a

discouraging procedure and practically the only permanent cure is to extract the affected tooth. In those cases where the area can be reached, an opening, if necessary, can be made through the gum, the root thoroughly scraped and polished, then after washing out the abscessed area, it should be cauterized with some cauterizing agent. Nothing gives better results than phenolsulphonic acid. With a proper glass syringe and a gold or platinum needle, the remedy can be injected into the abscess pocket. One thorough treatment should effect a cure. In curetting these cases it is far better to go a little beyond the affected territory rather than fail to remove all of the affected tissue and have the abscess recur. Where the abscess can be reached, thorough curettment and cauterization will effect a cure. That portion of the pericemental membrane which has been destroyed will perhaps never be regenerated, but if we succeed in having granulation fill in the area involved, even though the membrane is not regenerated over that particular surface of the root, the tooth can be saved and no subsequent trouble follow.

Filling Root Canals.—There are so many different methods of filling root canals, and there seems to be such a variance of opinion as to the best method of performing this operation, that it is with a degree of hesitancy that the author attempts to discuss this subject; yet it is one of the most important before the profession today, for upon this operation depends the success or failure of all the previous treatment associated with the pulpless tooth. This operation stands as a sort of dividing line between the subjects of *therapeutics* and *operative dentistry* proper. In discussing this subject the author will present the therapeutic aspect and describe a method of procedure which has proved successful in his practice.

It will be remembered that three factors were emphasized in the chapter on pulp removal and the subsequent treatment, viz.:

1. Established and maintained asepsis.
2. Preserve the color of the tooth.
3. Thoroughly fill the canal.

The author suggests filling all canals, which are large enough for a broach to enter, with gutta-percha in the manner which will be subsequently described. In connection with the preservation of the color of the tooth, it should be mentioned that *white base plate gutta-percha* should be used, especially for the purpose of dissolving in chloroform, or eucalyptol, making, respectively, chloro-percha and eucapercha. If this white substance is forced into the tubuli of the crown of the tooth, as it is liable to be; it will not change the color of the tooth structure as would the pink gutta-percha. A great many dentists have been moistening the canal, previous to filling with gutta-percha, with *oil of eucalyptus;* and, as a result, much unnecessary pericementitis has followed this operation.

If oil of eucalyptus is used at all, the refined oil only should be selected; and, far more satisfactory results will follow the use of *eucalyptol*, the most volatile constituent of oil of eucalyptus. While eucalyptol is irritating, it is not nearly as much so as is oil of eucalyptus. The author suggests modifying the irritating property of eucalyptol and enhancing its antiseptic power by combining menthol and thymol as suggested in the prescription for *eucalyptol compound* in the chapter on The Treatment of Non-septic Pericementitis.

In this proportion the agents added do not interfere with the solvent power of eucalyptol for gutta-percha; but if the amounts are increased to any appreciable extent this does not hold true.

In filling root canals it is always the safest practice to adjust the rubber dam, for asepsis must be established and maintained. The same agents can be used for sterilizing the teeth after the dam is adjusted as were described in removing pulps by the anesthetization method. The canals should be aseptic before the operation is attempted. If there is any doubt in this regard the operation should be deferred until the canals are in such a condition.

Filling Large Canals.—In filling large canals, especially those in connection with which abscesses have been treated, where the apex is large and where we ought not to expect to get a response from the patient when the gutta-percha cone reaches the apex, on account of the absorption in the apical area, it is best to measure the canal and then use one cone which approximately fits the canal rather than use two or three smaller cones with the possibility of forcing one through the apex and into the apical area. There is almost as much danger of forcing the root filling too far in large canals, as there is in not forcing it far enough in small canals. To measure the canal, cotton can be tightly wrapped around a smooth, sterile broach and inserted. When, by repeated trials the cotton fits the canal, a cone can be made of white base plate gutta-percha, which is slightly smaller than the tightly wrapped cotton. The canal should now be moistened with chloroform, flooded with white eucapercha, working the latter up or down into the canal with a fine smooth broach, exhausting the air. If cotton is wrapped around the broach used for this latter purpose, only a few shreds should be used; for we should avoid making a piston out of the broach and thus defeating the means of exhausting the air. This accomplished, the cone can be slowly and gently pressed to place. In filling large canals from which live pulps have recently been removed, the patient will generally flinch before the cone reaches the apex. When this occurs, we should wait a few moments, when the cone can be gently pressed much farther without causing the patient to flinch a second time. If these precautions are observed, they will be the means of

preventing much of the pericementitis following the filling of root canals.

Small Canals.—In filling all canals where we can enter nicely with a smooth broach, it is best to follow the technique outlined above, using a cone which will enter the canal. However much we may regret it, there are canals, especially in the molar teeth, so small and tortuous that even a fine, smooth broach will not enter; at least to any depth. It is useless to try to fill such canals with a gutta-percha cone. The methods of enlarging the canals by the use of acids and caustics, as referred to in connection with the destruction of pulp tissue in such canals, can be employed; but even with these agents it is often difficult to enlarge them sufficiently to admit a small cone. After the larger canal or canals in a multirooted tooth are filled in the ordinary manner, the smaller ones can be flooded with eucapercha and this preparation worked up or down into the canal. This process should be kept up for some time until we are certain that all air has been expelled and the canal filled with the plastic material. The sides of the pulp chambers can now be moistened with chloroform and a piece of base plate gutta-percha, selected and softened in the flame, can be packed into the pulp chamber, when pressure can be made towards the small canals and the plastic gutta-percha forced into them. This is much better practice than simply filling the mouth of the canal with a gutta-percha cone.

As previously mentioned there are many methods of filling root canals by which good results are attained. The method here outlined has served the author well. In closing this chapter I desire to say that no reasonable amount of time should be considered lost in treating the conditions discussed in this chapter and in properly preparing canals for the insertion of the filling material. Every tooth thus treated should be radiographed immediately after the root is filled, and if not satisfactory the operation should be repeated. There is much room for improvement in both the method and materials used in filling root canals; and investigation along these lines is being done at the present time. Perhaps the near future holds something in store for the profession. It is to be hoped so at least.

CHAPTER XXIII

THE CAUSES AND TREATMENT OF DISCOLORATIONS OF TEETH

BY J. P. BUCKLEY, PH. G., D. D. S., F. A. C. D.

General Considerations.—In the discussion of the methods of removing pulps from teeth and the subsequent treatment, the treating of gangrenous pulps and the various kinds of alveolar abscesses, the author endeavored to emphasize the necessity of *preserving or restoring the color of the tooth*. There is, perhaps, nothing more annoying to a conscientious dentist and to an appreciative patient than a discolored tooth in the patient's mouth. If the precautions, which have been mentioned in the preceding chapters, with reference to this factor are observed in the treatment of teeth, the necessity for bleaching may often be avoided; for after all that has been written on this subject is studied, it must be admitted that the most successful method of bleaching teeth is to so treat them that they will not need to be bleached. There are three principal sources of the discoloration of tooth structure, viz., pulp decomposition, remedial agents and metallic fillings. The greatest source is that of pulp decomposition. Many teeth containing gangrenous pulps are discolored before the patient presents for treatment. In those cases where the color is not lost the gangrenous condition can be corrected and the color preserved by the method of treatment outlined in a previous chapter.

There are two ways by which the discoloration is produced, *i. e.*, by solutions which stain the cement-like substance uniting the tubuli, and by the ingress into the tubuli of insoluble coloring substances. For instance, many remedial agents in solution such as oil of cassia, silver nitrate, etc., have the property of staining the cementing substance and producing discolorations; while the sulphids formed from certain metals, as for example in amalgam fillings, produce discoloration by virtue of being forced into the tubular structure of the dentin. If more care were taken in selecting remedial agents, used in the treatment of teeth, which would not stain the tooth structure, and if high grade alloys were selected in making amalgam fillings, the cavity properly prepared, amalgam inserted and polished when set, there would be few teeth discolored from these sources.

Occasionally, however, teeth have been observed to assume a pinkish hue shortly after some traumatic injury, rapid regulation or after the application of some irritating drug had been applied to some small exposure of the pulp as, for instance, arsenic trioxid. It was stated in a previous chapter, that it is always best to apply arsenic trioxid to the dentin immediately over the pulp, even though an exposure exists. Dr. E. C. Kirk, of Philadelphia, has offered a plausible explanation for the cause of this immediate discoloration. He says, "It is now known that the pink staining of the tooth is brought about by a rupture of the stroma of the red blood disks liberating their contained hemoglobin, which dissolves in the plasma, forming a solution of hemoglobin which readily penetrates the dentinal tubuli, the lumen of which is of insufficient diameter to admit the unbroken red corpuscle. This pink discoloration resulting from the infiltration of hemoglobin solution represents the first stage of tooth discoloration. The pink stain readily undergoes alterations, later on assuming a brownish tint, due to the breaking down of the highly complex molecule of hemoglobin into a reduction product known as hematin." But as has been stated, many teeth containing gangrenous pulps are discolored before the patient presents for treatment, and inasmuch as this is by far the greatest source it is well to try to ascertain definitely the true cause of the discolorations from this source; for, it is difficult and unsatisfactory to try to bleach a tooth when we have no knowledge of the nature of the pigment we are trying to bleach.

The principle which governs the successful bleaching of teeth is to chemically change the molecule of the pigment in such a manner as to destroy its color, or chemically change the insoluble coloring substance to a soluble form, when it can be washed out of the tooth structure. Attention will now be directed to the cause of discoloration from pulp decomposition as the author understands it. In the chapter on the Chemistry of Pulp Decomposition, the intermediate and end-products resulting from this complicated process were enumerated and it was ascertained that ammonia, NH_3, and hydrogen sulphid, H_2S, were the principal gases formed. It was also pointed out that the relative amount of nitrogen and sulphur found in the proteid molecule was 15 per cent of the former to 0.3 per cent of the latter, and from this fact it was reasoned that ammonia, a compound of nitrogen and hydrogen, was generated in far greater quantities in a gangrenous root canal, than hydrogen sulphid, a compound of hydrogen and sulphur; and that this latter gas did not assume the important rôle in the discoloration of teeth from this source, as had been so generally supposed.

It is quite generally conceded by those who have given this phase of the decomposition process their attention, that iron, Fe, is the most

important element to be considered in the many factors entering into the discoloration problem; and it is a common statement found in our text-books and journals that the discoloration is due to the formation of ferrous sulphid, FeS, which salt is supposed to be formed by the action of hydrogen sulphid upon the iron. This view is held by many writers, among whom is Dr. Kirk, who has perhaps given more thought to this subject than any other writer. The source of iron has been considered entirely from the decomposition of the hemoglobin of the red blood corpuscles; for it is well known that this compound contains iron, which is not characteristic of all proteid bodies. Dr. J. E. Hinkins, of Chicago, in his analysis of the enamel and dentin of human teeth, found that iron existed in both of these structures in combination with aluminum. It is not unlikely that future investigation will find that the iron from this source plays a part in the discoloration of tooth structure. It remains, however, to be demonstrated that ferrous sulphid is the true cause of the discoloration and the author doubts if this theory can ever be proved to be correct. From chemistry we learn that ferrous sulphid is a *black* compound and that no change takes place in the color or otherwise by exposing it to the air. Should the discoloration of tooth structure be due, then, to ferrous sulphid, as claimed by many writers, there would be no necessity, in treating gangrenous pulps, so far as preserving the color of the tooth is concerned, for using a remedy which can be hermetically sealed within the tooth. Clinical experience shows that a tooth containing a recently decomposed pulp, in a large percentage of cases, is not discolored, and that such a tooth will not change in color if the formocresol remedy is used in the treatment and always hermetically sealed.

Dr. Kirk admits that, "Ferrous sulphid, as such, cannot be held wholly accountable for the bluish-black color of the tooth which has reached the stage of permanent discoloration." Neither can the *green* nor *yellow* discolorations of teeth be attributed in any way to the presence of black ferrous sulphid; yet, the author is of the opinion that it is possible for this compound to be formed in the ultimate process of pulp decomposition as will be explained later on in this chapter. From the foregoing, it must be evident that it is necessary to search for other colored substances, besides black ferrous sulphid, which are possible to be formed in the process of pulp decomposition and which are capable of staining the tooth structure.

In articles which the author read before the Odontographic Society of Chicago (*Dental Review*, June, 1901, October, 1902), a theory was advanced which explained the variety of colors exhibited in discolored teeth, and while some criticism has been offered in regard to this theory nothing has been done now after twenty years to disprove its correctness,

therefore, he is still of the opinion, that it presents today the most rational solution of this question from both the chemical and clinical viewpoint.

As has been stated, ammonia is not only a constant end-product, but it is generated in far greater quantities than any other gas. It is well known that ammonia has the property of uniting chemically with water, which is always present in a gangrenous root canal, forming ammonium hydroxid, $NH_3 + H_2O = NH_4OH$. This reagent will act upon the soluble salts of iron, in both the ferrous and ferric forms, producing respectively, ferrous and ferric hydroxid, $Fe(OH)_2$, $Fe_2(OH)_6$. Therefore, it is not only possible, but quite probable, that the atomic iron which is liberated in the process of decomposition, from the hemoglobin or perhaps intermediate compounds containing it, unite with the ammonium hydroxid present, forming the hydroxid of the metal; and inasmuch as the compounds containing the iron are organic or weak, the ferrous hydroxid, in all probability, would be produced. Ferrous hydroxid is a *white* compound which readily absorbs oxygen when in the moist state and exposed to air, and gradually changes to ferric hydroxid, a *reddish-brown* compound. In this change there is an array of four distinct colors—*white*, *green*, *black* and *brown*—and in the blending of these four colors there is produced every variety of shades exhibited in discolored teeth. This seems to suggest a plausible explanation as to why teeth containing gangrenous pulps change color when air is admitted; also why a tooth containing a recently decomposed pulp is not discolored and does not readily change color until air is admitted. I fully recognize the fact that ferrous hydroxid is not the only compound of iron capable of producing color changes when moist and exposed to air. Nearly all of the ferrous compounds change more or less; but with the possible exception of ferrous carbonate, which could be formed, ferrous hydroxid is the only compound of iron possible to be produced, the color changes of which correspond to those seen in teeth which have reached the stage of permanent discoloration.

I have stated in this chapter that, in my opinion, it was also possible for ferrous sulphid to be formed ultimately by the putrefactive process; but it can only be produced by the hydrogen sulphid acting first upon the ammonia, forming ammonium sulphid, $H_2S + 2NH_3 = (NH_4)_2S$. This *alkaline* reagent will act upon the soluble salts of iron, precipitating the metal as ferrous sulphid. My conclusions, then, with reference to the true cause of the discoloration, are these: that the permanent yellow discoloration is due to the formation of ferric hydroxid; the bluish-black discoloration to a mixture of ferric hydroxid and ferrous sulphid—or to a failure of the ferrous hydroxid to become completely oxidized into the ferric form owing to a lack of moisture or oxygen; the other colors observed are transitory and are due to the gradual transition of the ferrous into the ferric

hydroxid. In coming to these conclusions I have accepted the statement that iron plays the most important rôle of all the elements entering into the discoloration problem; for if it were possible to remove the hemoglobin from the blood or the iron from the hemoglobin, I do not believe the dentin could be discolored by any compound possible to be formed by the process of pulp decomposition. If this be true, my reasoning is at least logical.

Having thus far, in this chapter, discussed the *cause* of the discoloration of tooth structure, the methods of restoring the normal color will now be considered.

When a case presents for bleaching there are three important things to be determined:

(1) Ascertain, if possible, the cause of the discoloration.

(2) Decide whether or not the color can be successfully restored.

(3) The selection of the proper bleaching agent with which to restore the color.

The general cause of the discoloration can usually be ascertained from the history of the case as related by the patient. Whether or not the tooth can be successfully bleached depends largely upon the cause of the discoloration, the condition of the tooth structure, and the length of time the tooth has been discolored. Experience will prove that the teeth which will permanently retain their color, after it is restored, are those that have a good bulk of dentin and which dentin can be protected by the remaining enamel and some filling material, referably porcelain if this material is at all indicated. I desire to emphasize the fact that it is folly to expect a tooth to retain its color any length of time after once being bleached unless *the dentin is properly protected.*

Having ascertained the cause of the discoloration and believing that the condition of the tooth structure justifies us in attempting to bleach the tooth, we come to the most important consideration, viz., the selection of the bleaching agent, with which the color can be restored with the least inconvenience to the patient and operator.

Methods.—All of the methods employed in bleaching teeth involve more or less chemistry; and form a chemical viewpoint there are two general methods of bleaching teeth—*oxidation* and *reduction.*

I. *Oxidation Method.*—This general method is of two kinds also *direct* and *indirect.*

(1) *Direct.*—By direct oxidation is meant the use of any agent or agents from which oxygen can be directly obtained. The agents used for the purpose are:

Sodium dioxid, Na_2O_2. Twenty-five per cent ethereal solution of hydrogen dioxid, H_2O_2. Alphozone, $(COOH. \quad CH_2. CH_2CO)_2.O_2$. Aluminum Chlorid Al_2Cl_6, and a three per cent aqueous solution of hydrogen dioxid. Oxalic acid, $H_2C_2O_4. 2H_2O$.

(2) *Indirect.*—By indirect oxidation is meant the use of any agent or agents by which oxygen can be obtained indirectly. The agents employed are such as will liberate nascent chlorin, Cl, a chemically active gas, which, in the presence of moisture seizes upon a molecule of water, H_2O, abstracts the atoms of hydrogen, H, forming hydrochloric acid, HCl, and liberates the oxygen, O, in the nascent state, as $H_2O + 2Cl = 2HCl + O$ (nascent). Some of the agents used for this purpose are:
Aluminum chlorid and a freshly prepared Labarraque's solution (Harlan).
Chlorinated lime and dilute acetic acid (Truman).
Powdered alum, $Al_2K_2(SO_4)_4$, and Labarraque's solution.
Solution of sodium chlorid electrically decomposed.

II. *Reduction.*—By reduction is meant the use of any agent or agents which will abstract oxygen from a compound containing it. The agents which have been recommended are, sodium sulphite, Na_2SO_3, 10 parts, and boric acid, H_3BO_3, 7 parts. These are mixed and placed within the tooth, moistened with water and hermetically sealed. (Kirk.) A reaction occurs between the two substances with the ultimate formation of sulphurous acid which has a great affinity for oxygen and is therefore a good reducing agent. In some cases where the tooth has been discolored by remedial agents and where it is desired to break up the color molecule, good results are obtained by this method. Whenever the method is used the tooth should subsequently be thoroughly washed with an alkaline solution such as a 10 per cent solution of sodium bicarbonate or borax to neutralize the acid.

In most cases of discoloration the direct oxidation method is preferable and in view of the fact that all of the agents used in the direct method of bleaching depend upon the generation of oxygen for their efficacy, it can readily be understood that the direct method is far more satisfactory. The fact, also, that hydrochloric acid is a constant by-product in the indirect method, thereby creating an *acid* medium, adds to the objectionable features of this method; for manufacturers have recognized for years that better results can be obtained in bleaching ivory, wool, hair, feathers, etc., when the bleaching process was carried on in an *alkaline* medium. This is likewise true in bleaching teeth. Believing then, that the direct oxidation method is far superior to the indirect, I shall not burden my readers by describing the latter method; but will direct attention to the detailed use of *sodium dioxid*—a direct oxidizing agent and one which, if its chemical properties are known and its dental application understood, the author believes to be the best agent for bleaching teeth thus far suggested to the profession.

Sodium dioxid was introduced by Dr. Kirk in 1893. It is a rare chemical, not because it is difficult to manufacture, but because of the fact that in the past there has been little demand for it. Its chemical activity precludes its use on soft tissue; hence, it is scarcely known to

the medical profession, and is not kept in many pharmacies. It is the oxid formed when sodium is allowed to burn briskly in dry air or oxygen. The product occurs in commerce as a yellow powder and is readily decomposed by water into caustic soda and oxygen. Because of this latter fact, much of the product obtained from wholesale druggists, labeled "sodium dioxid," is nothing but caustic soda. This accounts for the fact that many dentists have tried this method of bleaching and failed to get results. The fault is not with the method, but with the powder used. In order that we might be able to ascertain the efficacy of the chemical, some years ago I devised a simple chemical test for this purpose. In a clean, dry test tube place about 1 gm. (15 grs.) of the powder and to it add 1 or 2 c.c. (15 or 30 m.) of water. If the specimen is good sodium dioxid, enough oxygen should be generated to kindle a glowing splinter held at the mouth of the tube. Having tested the chemical and proved it to be sodium dioxid, and not caustic soda, the next thing is to properly prepare the tooth, which, of course, should have been previously treated and the root filled with gutta-percha. The rubber dam should be adjusted, if possible without the use of the steel clamp. The ligature should be wrapped twice around each tooth included in the dam, which should be at least two teeth on either side of the one to be bleached. This will prevent the by-product, caustic soda, from getting on the soft tissue and destroying it. The lower third of the root filling should now be removed with a good sized round bur—it being necessary, for permanent results, to bleach the tooth rootwise as far as possible. We are now ready to apply our bleaching agent. Both the dry sodium dioxid and a solution made by carefully dusting the powder into ice water is recommended to be used. The best results are obtained by using the dry powder, placing it into the cavity and with a platinum broach or pointed glass instrument, work the powder well up into the canal from which the root filling has been removed. Care should be taken not to use steel instruments, as the oxygen will attack the steel forming ferric oxid and therefore we may get into the tooth the pigment we are trying to remove. In some cases it is rather difficult to place the powder in the cavity without getting it on the patient's face or clothing. To overcome this a strip of unannealed 1:1000 platinum foil can be placed between the discolored and adjacent tooth, letting it extend above or below the cutting edge, as the case may be, when white base plate gutta-percha can be warmed and pressed against the lingual surfaces of the teeth included in the dam. This forms a pocket on the labial side into which the powder can be easily placed, using a little gold or platinum spoon or spatula. In more difficult cases a paste can be made of the powder and chloroform, in which it is insoluble, quickly packing the paste into the cavity, evaporating the chloroform, leaving the

dry powder where it is desired. Distilled water is now dropped upon the powder, causing a lively effervescence and the following reaction takes place: $Na_2O_2 + H_2O = 2NaOH + O$ (*nascent*). This nascent oxygen is a powerful oxidizing agent. It attacks and rapidly destroys any organic matter which may be present in the tubular structure of the dentin. It also thoroughly bleaches vegetable colors and acts upon any iron compounds which may have produced the discoloration. It converts ferric hydroxid, if present, into ferric oxid—still an insoluble compound. If ferrous sulphid is present in the moist state, it may be converted into ferrous sulphate, a soluble salt; but in the presence of caustic soda it would be reprecipitated as ferrous hydroxid, which, in turn, in the presence of oxygen, is at once reconverted into ferric oxid. Therefore, the pigment to be removed if our chemical reasoning is correct as to the cause of the discoloration from pulp decomposition, is ferric oxid, an insoluble compound and must be removed mechanically by washing the tooth. Its removal is facilitated by the by-product, caustic soda, acting upon any fatty substances—fat being an end-product of the putrefaction of the proteid material—which may be present in the tubuli. The result of this action being a soluble soap, the removal of which by washing, aids, as stated, the mechanical removal of the insoluble pigment.

It is my opinion that the ultimate success depends quite as much upon the mechanical removal of the coloring matter as upon the chemical destruction of it; therefore, the necessity for thoroughly washing the tooth after each application of the bleaching agent. Warm distilled water should be used in a strong syringe, letting a moist sponge absorb the water. The cavity is now dried, the color of the tooth observed and the process repeated, if necessary. Usually two or three applications are sufficient. If the color is not readily restored, the dentin can be saturated with a 2 per cent solution of sulphuric acid which can now enter the tubuli and chemically convert the oxids, that may not have been mechanically or otherwise removed by the saponifying and washing process, into sulphates. The salts produced are freely soluble and can readily be washed out by again using the warm water. When the tooth is satisfactorily bleached, a paste of precipitated calcium phosphate and distilled water can be placed in the cavity, packed into the lower third of the root and burnished, with a warm burnisher, against all exposed dentin. This is thoroughly dried by burnishing, the excess removed, and a light-colored, quick-setting cement used to form a base for the final filling which had better be inserted before the dam is removed.

In conclusion I desire to say that in the bleaching of teeth we find a practical application of the science of chemistry to the practice of dentistry; and that in the discoloration of tooth structure from the various sources can be found a fruitful field for further investigation.

CHAPTER XXIV

THE TREATMENT OF CHILDREN'S TEETH

BY C. N. JOHNSON, M. A., L. D. S., D. D. S., M. D. S., F. A. C. D.

This subject naturally divides itself into two parts—the management of the child, and the management of the teeth. Temperamentally, physically and nervously there is so much difference in children that to ignore this factor and prescribe a set method of practice for all cases would result in confusion, failure and disaster.

The first visit of a child to the dentist is usually a momentous occasion. Sometimes it is undertaken with the direst dread, at others with the most eager anticipations; all dependent on the point of view given the child by the parent. The dentist's duty is to study the temperament of the child most carefully, and he should not content himself with anything short of obtaining a perfect mastery over the child, at least during the time the latter is in his office. The means to be employed in gaining this mastery are as varied as are the manifestations of juvenile human nature—probably the most varied of anything in psychological study.

The chief factor, the fundamental basis of success in controlling children, is the exhibition of extreme kindness and the cultivation of infinite patience. Unless a dentist can bring this kind of an attitude to the management of his young patients he would better not attempt their treatment. And yet there are some children so unruly by nature and so spoiled by false training at home that to obtain command over them in the dental chair the operator must be firm with them almost to sternness. If the parent has no control over the child, as is sometimes unfortunately the case, then the dentist should be the means of giving the child what is probably its first real lesson in discipline. And let it be said that no class of men, not even medical practitioners, are placed in so favorable a relationship to these young patients for the purpose of instilling into them obedience and stability of character as is the dentist, and if the members of our profession would only rise to the possibilities of their opportunities in this regard they would do no small part in developing true manhood and womanhood in the rising generation. To bring up a child with no idea of individual responsibility, to foster a tendency toward avoiding any duty of a disagreeable nature, to always sprinkle roses for the child to tread upon, is

weakening in its effect and results in deterioration of character and the pitiable failure to meet the emergencies of life as they inevitably arise.

A discriminating dentist can do much in his professional relationship with these young minds to develop in them stamina and force of character, and it is sometimes the case that the first real experience of facing and properly meeting an issue is fought out in the dental chair. To be successful in the management of children under these trying circumstances a dentist must be a rare student of human nature, and he should early learn just when to be yielding and tender, and when to be firm as adamant. But let it always be remembered that under no circumstances, however trying the case may be, should he allow himself to lose his own self-control and display temper or impatience; and whenever it has been necessary to be firm and even severe, he should invariably soften his demeanor by the utmost kindliness and an unmistakable interest in the little patient's welfare. To gain complete control of a child who previously has never been controlled by any one is no mean achievement, and the sense of satisfaction in the good attained is well worth all the effort it requires to accomplish it.

One feature of the management of children in the dental office which in this enlightened age of child study would seem unnecessary of mention, but which unfortunately is still a factor in some instances, is the habit of deceiving the child as to what is to be done. There is no more fatal error, no more disastrous or appalling wrong, than to deliberately deceive a child, and the result of one such deception can never be fully estimated. To the dishonor of some parents we are occasionally asked even in the beginning of the twentieth century to become a party to such an iniquitous practice, but no dentist of any self-respect or manhood will ever enter into such a conspiracy. It is always well, of course, to destroy in the mind of the little patient any sense of fear by making as light as possible of the probable severity of the operation, and by the utmost tenderness and gentleness of demeanor; but to deliberately assure the child that a certain operation will not hurt in the least when it is almost certain to hurt, and worse than this to pretend to be applying some medicament to a tooth and then suddenly seize it with the forceps and extract it is a monstrous and cruel wrong.

Ordinarily the first visit of a child to the dental office should be so managed, if possible, that no work of a disagreeable nature is undertaken. Mothers should be instructed to bring their children early, even before the necessity seems apparent, so that the child forms the habit of having the teeth examined and gets acquainted with the dentist. Thus, when fillings have to made the ice is already broken and the way made easier. If the case has been deferred till toothache occurs, and the visit is one of necessity

for relief, the only operative procedure undertaken at this time should be merely to stop the pain. A sympathetic and personal interest should be manifest for the little sufferer, and the impression formed at this first visit that the dentist is a kind hearted gentleman and not at all to be feared. When once confidence is attained it will usually be found that most children will tolerate any necessary discomfort in having their teeth cared for provided their pride is appealed to in the proper manner and they are upheld as little men and little women.

But the dentist should have a care not to overtax the courage of a delicate child, and should constantly watch with the keenest eye for signs of wavering or undue nervous tension during an operation. It is sometimes better to do temporary work and retain the confidence of the child than to always attempt permanent operations and thereby run the risk of creating distrust and dread. This is particularly true of operations on the deciduous teeth where the object is more to keep them comfortable for a few years than to do artistic and permanent work.

The materials for filling deciduous teeth are limited to those easy of insertion and not too exacting in their requirements. When cavities occur in the proximal surfaces of the incisors they are usually better managed with oxyphosphate of zinc than with anything else. They are ordinarily shallow, and the fact that they are frequently quite sensitive prevents the operator from giving them any appreciable retentive form. Cement can therefore be used when nothing else will remain in place. These teeth do not often call for much operative interference owing to their early loss to make way for the permanent incisors, but with the deciduous molars the case is different. They remain four or five years after the incisors are gone, and the problem of saving them when they decay is sometimes exceedingly difficult. They should be given early and frequent attention when the mouth is susceptible to caries, with the aim always of checking the disease and keeping the teeth comfortable for mastication. The reason for this is not only that the child shall be enabled to properly prepare the food for digestion during these early years, which of itself is very important, but that proper habits of mastication are established at this impressionable age. If the deciduous molars are allowed to decay and become sensitive the child involuntarily forms the habit of bolting the food without proper mastication, and this habit once formed is likely to persist through life. There are many people today who do not masticate their food to the extent which their present masticating apparatus would warrant simply because they have formed the bad habit of bolting their food during youth.

Simple cavities in the occlusal surfaces of these teeth are not difficult to manage. They may be filled with oxyphosphate of zinc, oxyphosphate of copper, pink base-plate gutta-percha or amalgam, as is

indicated in the individual case. Amalgam is more reliable than either of the others provided a proper preparation of the cavity may be made and it does not reach too close to the pulp, but sometimes we are obliged to temporize with cement or gutta-percha.

The most difficult problem we meet in the management of deciduous teeth is to properly treat cavities occurring in the proximal surfaces of the molars. There are several factors in these cases tending to make them troublesome to control. They are usually sensitive, making them difficult of proper preparation for the retention of amalgam, which is the only permanent material we have for preserving them. Unless fillings are reasonably well anchored in these cavities they are likely to be loosened by mastication, and if we attempt too deep anchorage we endanger the pulp. In fact these teeth do not usually present much area of tooth tissue in which to form a cavity and it takes but little penetration of decay to involve the pulp. It is always best to avoid irritating the pulp if possible, and to this end it is frequently advisable to use some other kind of material than metal to fill them.

Much of the discomfort experienced by children in mastication is due to the packing of food in the interproximal spaces wherever decay has occurred in these surfaces. If cement is used it very rapidly wears away so as to present a space between the teeth and thus invite a lodgment of food. Not only this but frequently we find the teeth drifting slightly apart as the jaw expands preparatory to the eruption of the permanent teeth, all of which increases the difficulty. In cases where amalgam cannot be used and cement is unreliable the patient may be made more comfortable with gutta-percha than any other material, though this is, of course, more or less temporary in its service.

The problem is greatly complicated where two cavities face each other, and in some instances the surest method of making the teeth serviceable for mastication is to bridge across the interproximal space from cavity to cavity with gutta-percha. This is the only material by which two cavities may be joined in this way on account of the individual movement of the teeth. If a rigid material like cement or amalgam is used the filling will very shortly be loosened from one cavity or the other, but gutta-percha being more or less yielding will accommodate itself to the movement of the teeth without injury. If this plan is followed provision must be made to prevent the gutta-percha from being forced down between the teeth in the interproximal space, and this may be accomplished effectively by placing a metal guard of gold, platinum, or German silver across the interproximal space allowing the ends to rest on the gingival walls of the cavities and building the gutta-percha over it. This protects the gum most perfectly and

admits of serviceable mastication without discomfort. As the gutta-percha is worn away it may be renewed from time to time, and although this is at best a temporary operation yet it is in some of these troublesome cases the only procedure by which the teeth may be made serviceable.

In pulpless deciduous molars the case should be treated in the usual way, except that some care should be taken not to introduce medicines which have a disagreeable taste or odor. It is always desirable with children to avoid as much as possible anything which tends to create prejudice against having dental operations performed, and usually these deciduous cases may be brought under control by the use of the essential oils which are less objectionable than some of the more powerful antiseptics.

TREATMENT OF THE PERMANENT TEETH DURING CHILDHOOD

From the time the permanent teeth begin to erupt at about six years of age till the deciduous teeth are all lost and replaced by permanent ones at about twelve the care of the erupting teeth is a very important consideration, and in mouths where there is great susceptibility to decay of the teeth the problem of saving the permanent ones is sometimes perplexing.

When the incisors begin to decay in the proximal surfaces shortly after their eruption it is seldom that we can insert permanent fillings in them at once. It is, of course, better if this can be done, thus making one operation sufficient and creating in the mind of the patient the impression that dental operations are effective when properly performed. But there are many patients who lack the fortitude at such a tender age to go through the necessary tension to have thorough work performed, and it is better to make several operations on the one tooth at different times and preserve the courage of the child than to attempt a perfect piece of work at the outset and break the spirit of the patient, thus creating a dread of having dental work done.

But let it be borne in mind that just so soon as it is found possible to have the temporary fillings replaced with permanent ones this should be done. In these susceptible cases the teeth can never be made too secure against decay even by the very best work the operator is capable of, and it is therefore well not to trust to temporary work longer than necessary. But in this connection it should be said that the attempt to use gold before the child is sufficiently under control to admit of doing a perfect piece of work will as certainly lead to failure as will the use of other materials more temporary in their nature. We must have a good technique in any operation calculated to be permanent and the requirements of gold in this respect are more exacting than for any other

filling. In some instances we may employ inlay work in children's teeth before they will tolerate the exactions of gold foil filling and thus obtain a better result than by the use of any of the plastic materials.

Each case should be studied carefully with the idea of learning the temperament of the child and knowing how to gain such control as shall permit of the best service. The practice of dentistry in its highest attainment is a constant study of conditions, conditions of the mind, conditions of the teeth, conditions of the surrounding parts—all of which materially affect us in the treatment of every case. And in this connection there is no other one thing of equal importance in the ultimate saving of the teeth and the maintenance of a healthy mouth than the establishment during these early years of the correct principles and practice of oral hygiene. It is not the province of the present chapter to go fully into this phase of the question, but it should be said in passing that no dentist is doing his full duty to the rising generation who fails to impress upon his young patients the importance of properly caring for the teeth and gums, or who does not give full instructions as to how this should be done. This should also be followed by a constant surveillance to see that his instructions are carried out.

A very necessary consideration in the treatment of children's teeth is to watch carefully the condition of the first permanent molar. This tooth is one of the most important in the entire arch. It is the chief standard bearer of the jaws during the period when the deciduous teeth are being lost and the other permanent teeth are coming into place, and if lost early it invariably results in the jaws dropping closer together than normal which detracts materially from the force of character of the face. If it is lost subsequently to the eruption of the second permanent molar and the bicuspids it produces a tipping of the other teeth into the space so as to disarrange the occlusion. No arch is ever perfectly normal with the first permanent molar missing, and even in those cases where the space has entirely closed by the approach of the second molar and bicuspid and where the occlusion seems good from the buccal aspect it will be found defective if models are made and a careful examination is given the lingual aspect.

In view of its early eruption it is peculiarly susceptible to decay, and should therefore be watched most carefully and preserved by filling. Where it has been extensively broken down by caries before it comes to the dentist it may usually be restored to full functional usefulness by the inlay method, and no pains should be spared to place it in a condition of health and service.

As has already been stated, one of the chief functions of the dentist in his treatment of children is to educate them to the importance of

properly caring for the teeth, and in respect of the first permanent molar it may be said that this education should begin with the parent before the child is of responsible age so that the frequent error of mistaking this tooth for a deciduous one and allowing it to go by default should not be committed. Parents should be instructed to bring their children to the dentist not later than the third or fourth year, and then the coöperation of the dentist, the parent and the child should result in every individual growing up with a good, serviceable set of teeth.

CHAPTER XXV

LOCAL ANESTHESIA

BY HERMANN PRINZ, A. M., M. D., D. D. S.

History.—The elimination of pain during surgical operations is inseparably interwoven with the history of the human race. It has always been the aim of those interested in the cure of bodily ills to relieve pain in some empirical manner. The efforts to solve the riddle of painless operations were, however, seemingly so very futile that even as late as 1832 Velpeau was led to express his pessimism as follows: "To escape pain in surgical operation is a chimera, which we are not permitted to look for in our time." Little did he expect that he stood at the very threshold of the discovery of anesthesia and that less than a decade later the "nirvana" of painless operations would be an accomplished fact. And when Dieffenbach, in 1847, wrote these classical words regarding the use of ether as an anesthetic, "the beautiful dream, to eliminate pain, has become a fact—pain, the highest consciousness of our earthly existence, its clearest conception of the imperfections of our body, it has to bow low before the powers of the human mind," the world at large awakened to the fact that pain had been conquered.

The discovery of anesthesia is essentially to be credited to the dental and medical profession of the United States, and the names of Crawford W. Long, Horace Wells, William P. G. Morton and Charles F. Jackson are inseparably connected with it. "If America has contributed nothing more to the stock of human happiness than anesthetics, the world would owe her an everlasting debt of gratitude," said the late Samuel D. Gross, the eminent surgeon, who had ample opportunity to observe in his own operating room the most remarkable changes that followed the introduction of anesthetics.

From an historical viewpoint, comparatively few important methods for the purpose of locally obtunding pain are to be recorded prior to the introduction of cocain. The compression of nerve trunks for the abolition of pain seems to be of an old and unknown origin, which was revived by Guy du Chauliac and Ambroise Paré, and finally found a permanent place in surgery as the Esmarch elastic bandage. Physically reducing the temperature of a part of the body by the application of cold was instituted much later. Bartholin and Severino introduced this method in the middle

of the sixteenth century. It became a lost art, however, until John Hunter, of London, again called attention to its benefits by demonstrating it upon animals, and Larray, the chief surgeon of Napoleon's army, employed it for amputating purposes (1807). James Arnott, in 1849, utilized a freezing mixture, consisting of ice and salt, as a means of producing local anesthesia. Through the efforts of Sir B. W. Richardson, in 1886, it was placed on a rational basis by the introduction of the ether spray. The various narcotics which were employed for internal purposes were also made use of as local applications. Mandragora, henbane, aconite, the juice of the poppy head, and many other analgesic drugs enjoyed world-wide reputation. There is probably no other medical plant around which clusters more mysterious and quaint associations than Mandragora. It should be remembered, however, that mandrake, or mandragora (atropa mandragora), must not be confounded with American mandrake, or May apple (podophyllum peltatum), to which it bears no relation.

The empirical search for new methods and means pressed the mysticism of the electric current into service, opening a prolific field to the charlatan, which even to this day has not lost its charm. Richardson's voltaic narcotism for a time attracted the attention of the medical and dental profession. Its inventor claimed "that by the action of a galvanic current passing through a narcotic solution, held in contact with the part to be operated upon, some of the narcotic substance passed much more rapidly into the tissues and that in many instances complete local anesthesia was in this way produced by solutions which are entirely inert when applied, even to the most delicate tissue, without the galvanic current." This very same principle, discovered by Reuss in 1807, and introduced by him as "electric endosmosis," or as "cataphoresis," by E. du Bois-Raymond, was "newly discovered" and reintroduced into dentistry about two decades ago. In cyclonic fashion it swept over the globe, but today it is almost forgotten. Electric or galvanic anesthesia was suggested as far back as 1851 by A. Hill, of Connecticut. Francis, in 1858, recommended the attachment of the electric current to the well-insulated handles of the forceps for the painless extraction of the teeth, and, as dental depots offer appliances of this nature for sale, it seems that this method is still in vogue with some operators. According to Regner and Didsbury, as cited by Sauvez, a current of electricity of high frequency, when directed toward the long axis of a tooth for a shorter or longer period previous to its extraction produces insensibility to pain. In 1880 Bonwill suggested his method of "rapid breathing as a pain obtunder," which he claimed "produces a similar effect to that of ether, chloroform and nitrous oxide gas in their primary stages." In the early days of modern dentistry many feeble efforts were made to alleviate pain during trying operations. Chloro-

form, alcohol, ether, aconite, opium, the essential oils, and many other drugs were the usual means that were employed, either separately or as compounds, usually under fanciful names, for such purposes. Snape's calorific fluid, composed of chloroform tincture of lemon balm, and oil of cloves; nabolis, consisting of a glycerid of tannic acid and a small quantity of chloral hydrate; Morton's letheon, which was sulphuric ether mixed with aromatic oils, are examples of proprietary preparations which enjoyed quite a reputation in their time. In 1853 Alexander Wood introduced a method of general medication by means of hypodermic injections, and a few years later the French surgeon Pravaz modified the old style syringe for this special purpose, which since is known as the "Pravaz" or hypodermic syringe. At once it was suggested to apply such drugs as morphin or tincture of opium for the purpose of producing local anesthesia. The results were not encouraging, however, until cocain was advocated. Cocain was discovered by Niemann in 1859, but it required twenty-five years to make known the remarkable anesthetic properties which this alkaloid possesses when applied in the ready soluble form of its hydrochloric salt. It was on September 15th, 1884, that Carl Koller, of Vienna, presented this epoch-making communication at the Ophthalmologic Congress at Heidelberg, in which he demonstrated the effects of cocain as a local anesthetic. With the introduction of this drug into therapeutics, local anesthesia achieved results which were beyond expectations, and its final adoption created a new era in local anesthesia.

Means of Producing Local Anesthesia—The term anesthesia (without sensation), which was suggested in 1846 by the great physicianlitterateur, Oliver Wendell Holmes, to Dr. Morton, is usually defined as an artifical deprivation of all sense of sensation, while the mere absence of pain is referred to as analgesia. Correctly speaking, the term local anesthesia is partially a misnomer. In producing local anesthesia we do not fully comply with all the requirements that anesthesia demands, because a part of the sensorium—the sense of touch for instance—is not abolished. The term local anesthesia has, however, acquired such universal recognition that it would seem unwise to recommend a change.

Anesthesia may be artificially produced by inhibiting the sensory nerve fibers at their central end-organs in the brain or at their peripheral end-organs in the tissues, thus producing general and local anesthesia. Local anesthesia may be obtained in two definite ways. We may inhibit the function of the peripheral nerves in a circumscribed area of tissue, and we refer to this process as "terminal anesthesia," while, if we block the conductivity of a sensory nerve trunk somewhere between the brain and the periphery, we speak of it as "conduction anesthesia." Conduction anesthesia may be produced by injecting into the nerve trunk proper—

endoneural injection—or by injecting into the tissues surrounding a nerve trunk—perineural injection. The latter form is the usual method pursued when conduction anesthesia for dental purposes is indicated. Specific forms of local anesthesia may also be produced by paralyzing the sensory ganglia in the brain or in the spinal cord; these methods have, however no bearing on the subject under consideration.

Local Anesthesia

- Terminal anesthesia
  - Surface Anesthesia
  - Subperiosteal Anesthesia
  - Peridental Anesthesia
  - Pressure Anesthesia
- Conduction anesthesia
  - Endoneural Anesthesia
  - Perineural Anesthesia

The successful practice of local anesthesia involves the carefully adjusted co-operation of a number of important details, each one constituting a definite factor in itself, which, when neglected, must necessarily result in failure. As a whole, the practice of local anesthesia by the hypodermic method represents the composite of the following factors:

1. A sterile solution of drugs possessing active anesthetic potencies and which, in their composition, must correspond to the physical and physiologic laws which govern certain functions of the living cell.
2. A carefully selected sterile hypodermic armamentarium.
3. A complete mastery of the technique.
4. A proper selection of the correct methods of injection suitable for the case on hand.
5. Suitable preparation of the site of injection.
6. The complete co-operation of the patient.
7. Good judgment of prevailing conditions.

Physiologic Action of Anesthetics.—According to more recent therapeutic conceptions, it is generally recognized that a drug or combination of drugs which simultaneously produce local anemia and inhibition of the sensory nerves in a circumscribed area of tissue is the local solution of the question of local anesthesia. Certain important factors, however, relative to the physiologic and physical action of the solution employed for hypodermic injection upon the cell govern the successful application of such methods. It is of prime importance, therefore, to comply with the laws regulating the absorption of injected solutions—osmotic pressure.

If we separate two solutions of salt of different concentration by a permeable animal membrane, a continuous current of salt and water results, which ceases only after equalization of the density of the two liquids—that is, until equal osmotic pressure (according to the Boyle-Van't Hoff law) is established. The current passes in both directions, drawing salt from the stronger to the weaker solution, and water vice versa,

until osmotic equilibrium is obtained. The resultant solutions are termed, according to De Vries, isotonic.

Osmotic pressure is a physical phenomenon possessed by water and all aqueous solutions, and is dependent on the number of molecules of salt present in the solution and on their power of dissociation. In organized nature these osmotic interchanges play an important rôle in regulating the tissue fluids of both animals and plants. In the animal tissue the circulation depends principally upon the mechanical force exerted by the heart. The life of the cell depends on the continuous passage of these fluids, which furnish the nutrient materials, consisting of water, salt and albumin. These chemicals are normally present in certain definite proportions. The membrane of the living cell is, however, only semi-permeable—that is, the cell readily absorbs distilled water when surrounded by it. The cell becomes macerated, loses its normal structure, and finally dies. If on the other hand, the surrounding fluid be a highly concentrated salt solution, the solution absorbs water from the cell; no salt molecules enter into the cell body proper. The cell shrinks, and finally dies. This process of cell death is, in general pathology, referred to as necrobiosis. Another important factor teaches that all aqueous solutions that are isotonic possess the same freezing point—that is, all solutions possessing an equal freezing point and equi-molecular, and possess equal osmotic pressure. This law of physical chemistry has materially simplified the preparation of such solutions. The freezing point of human blood, lymph, serum, etc., has been found to equal approximately 0.55 degrees C., which in turn corresponds to a 0.9 per cent sodium chlorid solution. Such a solution is termed a physiologic saltine solution. In the older works on physiology a 0.6 per cent sodium chlorid solution is referred to as a physiologic saltine solution, and corresponds to the density of the blood of the frog. A slight deviation above and below the normal percentage of the solid constituents is permissible. When physiologic saline solution at body temperature is injected into the loose connective tissues under the skin in moderate quantities, neither swelling nor shrinking of the cell occurs. A simple wheal is formed, which soon disappears, and, as no irritation results, consequently no appreciable pain is felt. Other similar bodies that are equally soluble in water act in the same manner, with the exception of the salts of the alkali and alkaline earth metals—as potassium or sodium bromid. The latter substances produce intense physical irritation, followed, however, by prolonged anesthesia, and in consequence are termed by Liebreich painful anesthetics. If, on the other hand, simple distilled water is injected, only a superficial anesthesia is produced; the injection itself is very painful, and acts as a direct protoplasm poison by maceration of the cell contents, which results

in the death of the cell. If distilled water approximately at a ratio of ten drams to the pound of body weight is injected into dogs, they will succumb in a short time. The injection of higher concentrated salt solutions produces opposite effects; water is removed from the tissues with more or less pronounced pain, and followed by superficial anesthesia. The red blood corpuscles are extremely susceptible to any injected fluid which is not isotonic in its nature. They are universally destroyed (hemolysis) by the injection of fluids which are not represented by an isotonic saltine solution. Severe tissue disturbances result, which may terminate in necrosis. Hypotonic solutions—solutions containing less than 0.9 per cent of sodium chlorid—cause swelling of the tissue, while hypertonic solutions—solutions containing more than 0.9 per cent of sodium chlorid—produce shrinkage. These manifestations are proportionately the more intense the further the solution is removed from the freezing point of the blood. Furthermore, hypotonic as well as hypertonic solutions require much more time for their absorption than isotonic solutions, as the osmotic pressure has to be standardized to the surrounding fluids—that is, to the isotonic index of the tissue fluids. Local anemia, or ischemia—a temporary constriction of circulation—prevents, as it has been experimentally shown, the rapid absorption of fluids that are injected into the affected area. Retarded absorption of the injected fluid, holding poisonous drugs in solution, means increased action of these poisonous drugs within the injected area. Increased action denotes increased consumption of the poisoned drugs, and, as a consequence, there is less danger from general absorption.

The more important means applied for the purpose of producing local anemia are:

1. The Esmarch elastic bandage.
2. The application of cold.
3. The extract of the suprarenal capsule, or its synthetic substitutes.

Some observers have maintained that local anemia produces anesthesia. This is not, however, the case, as it is merely an important means to confine the injected anesthetic to the anemic region, and thus bring about an increased and prolonged action of the drug. Consequently the concentration of the anesthetic solution may be of a lower percentage, which, of course, lessens the danger of intoxication. For plausible reasons the Esmarch elastic bandage cannot be made use of for dental operations.

Physically reducing the temperature of the body by the application of cold (ice pack, ice and salt mixture, cold metals, etc.) was practiced by the older surgeons. James Arnott, in 1848, suggested the adoption of diminished temperature as "a safer mode than any hitherto in use of producing insensibility in surgical operations," and Blundell, in 1855, advocated ice packs and salt solutions as means of pro-

ducing "local anesthesia by congelation" for dental purposes. Through the efforts of Sir B. W. Richardson, in 1866, this method was placed on a rational basis by the introduction of his ether spray. To obtain good results, a pure ether (boiling point 95° C.), free from water, is necessary. Certain other hydrocarbons possess similar properties in varying degrees, depending on their individual boiling point. In 1867, Rottenstein called attention to the use of ethyl chlorid as a refrigerating agent, and Rhein, in 1889, introduced methyl chlorid for the same purpose. In 1891 Redard reintroduced ethyl chlorid as a local anesthetic, which since has become known by many trade names as antidolorine, kelene, narcotile, etc.—and mixtures of the first two in various proportions, known as anestol, anestile, coryl, methethyl, etc., are extensively used in minor oral and general surgery. A pure ethyl chlorid (boiling point 55° F., 13° C.) is best suited for this purpose, as it lowers the temperature of the tissues sufficiently to produce a short superficial anesthesia in a few minutes. Too rapid cooling or prolonged freezing by methyl chlorid (boiling point −12° F., −24° C.), or the various mixtures thereof, produce deeper anesthesia, but such procedures are dangerous. They frequently cut off circulation in the affected parts so completely as to produce sloughing (necrosis). Liquid nitrous oxid gas, liquid or solid carbonic acid (recently known as carbonic acid snow), and liquid air, all of which have a boiling point far below zero, are recommended for similar purposes, but they require cumbersome apparatus and are extremely dangerous.

Ethyl Chlorid and Its Administration.—Ethyl chlorid—Monochlorethane; hydrochloric ether, C_2H_5Cl. "A haloid derivative, prepared by the action of hydrochloric acid gas on absolute alcohol." At normal temperature, ethyl chlorid is a gas, and under a pressure of two atmospheres it condenses to a colorless, mobile, very volatile liquid, having a characteristic, rather agreeable, odor and burning taste. It boils at about 55° F. (13° C.) and is very inflammable, burning with a smoky, green-edged flame. It is stored in sealed glass or metal tubes, and when liberated at ordinary room temperature (70° F., 21° C.) it evaporates at once. In commerce it is supplied in plain or graduated glass tubes of from 3 to 60 grams capacity, or stored in metallic cylinders holding from 60 to 100 grams or more. To remove the ethyl chlorid from the hermetically sealed smaller tubes, the neck has to be broken off, while the larger glass and metallic tubes are provided with suitable stoppers of various designs to allow definite amounts of the liquid to be released.

Mode of application. For the extraction of teeth, immediate removal of the pulp, opening of abscesses, and other minor operations about the oral cavity, the tube should be warmed to body temperature, by placing it in heated water, and its capillary end should be held about

six to ten inches from the field of operations. The distance depends on the size of the orifice of the nozzle, and complete vaporization should aways be produced. The Gebauer tube is fitted with a spray nozzle, which shortens the distance to one or two inches, and is especially well adapted for dental purposes. The stream is directed upon the tissues until the latter are covered with ice crystals and have turned white. For the extraction of teeth the liquid should be projected directly upon the surface of the gum as near the apex of the root as possible, but care should be taken to protect the crown of the tooth on account of the painful action of cold on this part. Tissues to be anesthetized should first be dried and well surrounded by a film of vaselin or glycerin, and protected by cotton rolls and napkins, to prevent the liquid from running into the throat. Let the patient breathe through the nose. Occasionally light forms of general anesthesia are induced by inhaling the vapor. On account of the difficulty of directing the stream of ethyl chlorid upon the tissues in the posterior part of the mouth, it is not successfully applied in those regions. The intense pain produced by the extreme cold prohibits its use in pulpitus and acute pericementitis. To anesthetize the second and third branch of the fifth nerve, it is recommended to direct the stream of ethyl chlorid upon the cheek in front of the tragus of the ear, but the author has not seen good results from such a procedure. Caution should be exercised in using ethyl chlorid near an open flame or in conjunction with the thermocautery, as severe burns have resulted by setting the inflammable vapor on fire.

Within the last decade the active principle of the suprarenal capsule has evoked extensive comments in therapeutic literature. It has been isolated by a number of investigators under different names, as epinephrin by Abel (1897), suprarenin by Fuerth (1898), and adrenalin by Takamine and Aldrich (1901). Many other titles are given to this chemical—as epinephrin, adnephrin, adrin, paranephrin, suprarenalin, supracapsulin, hemostasin, etc. Whenever we refer here to the hydrochloric salt of the alkaloid of the suprarenal capsule, we speak of it as adrenalin, the term which is at present preferred in the United States. Adrenalin is a grayish-white powder, slightly alkaline in reaction, and perfectly stable in dry form. It is sparingly soluble in cold and more soluble in hot water, is insoluble in ether or alcohol, with acids it readily forms soluble salts. The preparation that is employed mostly for therapeutic purposes is a solution of adrenalin hydrochlorid in a 1 to 1000 physiologic salt solution, to which preservatives—as small quantities of chloretone, thymol, etc.—are added. Adrenalin solution does not keep well. On exposure to air, and especially in the presence of even minute quantities of an alkali, it is easily oxidized, becoming pink, then

red, and, finally, brown, and with this change of color its physiologic property is destroyed. If the adrenalin solution be further diluted, it becomes practically worthless within a few days.

When adrenalin is injected into the tissues, even in extremely small doses, it temporarily raises the arterial blood pressure, acting as a powerful vasoconstrictor by stimulating the smooth muscular coat of the blood vessels, and thus produces local anemia. Large doses finally reduce the blood pressure, and heart failure results. The respiration at first quickly increases, but slows down and, finally, stops with expiration. Its action is largely confined to the smooth muscle fibers of the peripheral vessels. Adrenalin is destroyed by the living tissue cells, the body ridding itself of the poison in some unknown manner. While adrenalin does not possess local anesthetic action, it increases very markedly the effect of certain anesthetics when combined with them. Very recently it has been shown by Esch that adrenalin possesses a specific action on nerve tissue, viz.: It prepares the latter tissue in a peculiar way, so as to take up the anesthetic more readily. Esch compares this action with the use of a mordant in the dyeing industry, viz.: To "fix" the color. These observations are of vast importance in connection with the production of local anesthesia. Carpenter, Peters, Moller, and others referred to the use of adrenalin in this respect, and, finally, Braum, in 1902, published his classic researches, and to him and his co-workers, especially Heinze and Læwen, belong the credit of establishing a rational basis for the production of local anesthesia. It is claimed that secondary hemorrhage frequently occurs after the anemia produced by the adrenalin has subsided, and that tissues themselves suffer from the poisoning effect of the drugs, resulting in necrosis. Such results are produced only by the injection of too large quantities of the drug, which by their deeper action close up the blood vessels, and, if the tissues are too long deprived of the circulation, we are able to understand why sloughing may result. Small doses of adrenalin have no effect upon the tissues or on the healing of a wound. Palpitation of the heart and muscular tremor, which were occasionally noticed in the early period of the use of the drug, are the direct result of too large doses. Recently a synthetic adrenalin has been successfully prepared by Stolz, which, with hydrochloric acid, forms a stable and readily soluble salt. It is known as synthetic suprarenin hydrochlorid. The new chemical has been carefully tested physiologically and in clinical work, and the general consensus of opinion points to the fact that it is not alone equal, but in certain respects superior, to the organo-preparations. Synthetic suprarenin solutions are relatively stable, and their chemic purity insures uniform results. They are comparatively free from dangerous side actions. The writer's observations regarding the

value of synthetic suprarenin relative to its actions and its general behavior is in full accordance with the above statements, and its advantages over the organo-preparations has led us to adapt it as a component in the preparation of local anesthetic solutions. For dental purposes—that is, for injecting into the gum tissue—the dose may be limited to 1 drop of the adrenalin solution (1 to 1000) or the synthetic suprarenin solution (1 to 1000), added to each cubic centimeter of the anesthetic solution, 5 drops being approximately the maximum dose to be injected at one time.

The dosage of the relative amounts of adrenalin solution may be arranged as follows:

Add 1 drop of adrenalin to 1 c.c. of the novocain solution.
Add 2 drops of adrenalin to 3 c.c. of the novocain solution.
Add 3 drops of adrenalin to 5 c.c. of the novocain solution.
Add 4 drops of adrenalin to 8 c.c. of the novocain solution.
Add 5 drops of adrenalin to 10 or more c.c. of the novocain solution.

Cocain Hydrochlorid.—It is the principal alkaloid obtained from coca leaves (erythroxylon coca) a large shrub indigenous to tropical South America. It appears in colorless crystals, flaky, lustrous leaflets or white powder; it is odorless, has a saline, slightly bitter taste and produces when placed upon the tongue a tingling sensation followed by numbness. At ordinary temperature it is soluble in about one-half part of water, about three parts of alcohol and glycerin, also soluble in chloroform, ether and olive oil. Its aqueous solution is neutral to litmus paper. Prolonged heating of the salt or its solution produces decomposition of the chemical into methyl alcohol, benzoic acid and ecgonin. Solutions of cocain are unstable, they should preferably always be made fresh when wanted. Cocain hydrochlorid is incompatible with alkali hydrates or carbonates, salicylates, benzoates, bromids, and iodids, the mercury salts and silver nitrate. As early as 1860, Niemann noted the fact that cocain when applied to the tongue produced local anesthesia; later investigations, especially those of Von Anrep (1879) were not fully appreciated until Carl Koller, of Vienna, later of New York, brought it before the medical profession in a paper read before the Congress of Ophthalmologists at Heidelberg in 1884. Cocain is a general protoplasm poison, possessing a selective power for the sensory nerve elements. It paralyzes the nerve cells, fibers and endings and produces vaso-constriction at the place of its application. The respiration is at first accelerated, later it diminishes; respiratory paralysis is the usual cause of death. The pulse is quickened, later it is slow and weak; at first, the blood pressure rises, then falls and collapse results. Local anesthesia, according to Preyer's conception, is produced as follows: Cocain possesses a definite affinity for the living protoplasm of the nerve

cell; it enters with it into a labile union, thus producing local anesthesia, which lasts until this temporary union is broken up by releasing the chemical, not as the original cocain, however, but as an inert compound of a simpler structure. In other words, the living tissues rid themselves of the poison in some unknown manner. In dead tissue, the injected cocain will suffer no change whatsoever.

With our increased knowledge of the action of cocain upon the tissues and a proper technic of the injection, dangerous results are comparatively rare at present. No direct antidotes are known; the treatment of general intoxication is purely symptomatic. Anemia of the brain, which is of little consequence, may be overcome readily by placing the patient in a recumbent position or by complete inversion, if necessary. As a powerful dilator of the peripheral vessels the vapors of amyl nitrite are exceedingly useful; it is best administered by placing 3 to 5 drops of the fluid upon a napkin and holding it before the nostrils for inhalation. Flushing of the face and an increase in the frequency of the pulse follow almost momentarily. For convenience, amyl nitrite may be procured in small glass capsules, holding the necessary quantity for one inhalation. Nausea may be remedied by administering small doses of spirit of peppermint, aromatic spirits of ammonia, etc. To overcome the disturbances of respiration quickly, instituted artificial respiration is the alpha and omega of all methods of resuscitation. In cases of shock, Mumford recommends the hypodermic injection of morphin. Engstadt lauds very highly the administration of ether for such purposes and claims that it is *the* antidote for cocain and novocain. To obtain the best results, the ether should be administered upon a mask by the drop method and only to the degree of mild surgical analgesia.

The relative toxicity of a given quantity of cocain solution depends upon the concentration of the solution. Reclus and others have clearly demonstrated that a fixed quantity of cocain in a 5 per cent or 10 per cent solution is almost equally as poisonous as five times of the same quantity in a 1–5 per cent solution. From the extensive literature on the subject, we are safe in fixing the strength of the solution for dental purposes at 1 per cent. This quantity of cocain raises the freezing point of distilled water just a little above 0.1° C. To obtain an isotonic solution corresponding to the freezing point of the blood, 0.8 per cent of sodium chlorid must be added. Having thus prepared a cocain solution which is equal to the blood in its osmotic pressure upon the cell wall, it is now necessary to aid the slightly vaso-constrictor power of the drug by the addition of a moderate quantity of adrenalin. As stated above, 1 drop of adrenalin added to 2 c.c. of the isotonic cocain solution is sufficient to produce the desired effect.

A suitable solution for dental purposes may be prepared as follows:

Cocain hydrochlorid	5 grains
Sodium chlorid	4 grains
Sterile water	1 fluid ounce

To each syringeful (30 minims) add 1 drop of adrenalin chlorid solution, when used.

Ever since the introduction of cocain into materia medica for the purpose of producing local anesthesia, quite a number of substitutes have been placed before the profession, for which superiority in one respect or another is claimed over the original cocain. The more prominent members of this group are tropacocain, the eucains, acoin, nirvanin, alypin, stovain, novocain, and, very recently, quinin and urea hydrochlorid. None of these compounds, with the exception of novocain has proved satisfactory for the purpose in view. The classical researches of Braun have established certain factors which are imperative to the value of a local anesthetic. These factors concern their relationship to the tissues in regard to their toxicity, irritation, solubility and penetration, and to the toleration of adrenalin.

There is no need at this moment to enter into a discussion of the pharmacologic action of the drugs usually classified as local anesthetics. Let it suffice to state how the above-mentioned drugs fulfil the demands of Braun. Tropacocain is less poisonous, but also less active than cocain, it completely destroys the action of adrenalin; the eucains partially destroy the adrenalin action, they are, comparatively speaking, equally as poisonous as cocain; acoin is irritating to the tissues and more poisonous than cocain; nirvanin possesses little anesthetic value; alypin and stovain are closely related, producing pain when injected, which occasionally has resulted in necrosis. Quinin and urea hydrochlorid reacts strongly acid and, as a consequence, severely damages the tissues in the injected area. As we have recently shown elsewhere it possesses no advantage when employed as a local anesthetic in dental operations but has many disadvantages as compared to cocain or novocain.

Novocain alone fully corresponds to every one of the above claims. Its toxicity is about two to six times less than cocain; it does not irritate in the slightest degree when injected, consequently no pain is felt from its injection per se; it is soluble in its own weight of water; it will combine with adrenalin in any proportion without interfering with the physiologic action of the latter, and it will be readily absorbed by the mucous membrane. The studies of Biberfield and Braun brought to light another extremely interesting factor concerning the novocain-adrenalin combination. Both experimenters, working independently of each other, observed that the adrenalin anemia on the one hand,

and the novocain anesthesia on the other hand were markedly increased in their total effects upon the tissues. Consequently, a small quantity of this most happy combination is required to produce the same therapeutic effect as a large dose of each individual drug alone would produce when injected separately. The injection of a solution of the combined drugs is precisely confined to the injected area; general effects are, therefore, rarely produced.

Novocain is the hydrochloric salt of a synthetically prepared alkaloid, the methyl ester of p-aminobenzoic acid. It is a white crystalline powder, or colorless needle-shaped crystals, melting at 263° F. (156° C.). It may be heated to 200° F. (120° C.) without decomposition. It dissolves in an equal amount of cold water, the solution having a neutral character; in cold alcohol it dissolves in the proportion of 1 to 30. Caustic alkalies and alkaline carbonates precipitate the free base from the aqueous solution in the form of a colorless oil, which soon solidifies. It is incompatible with the alkalies and alkaline carbonates, with picric acid, andthe iodids. Its solutions may be sterilized by boiling without decomposition.

As stated above, the relative toxicity of a given quantity of cocain in solution depends upon its concentration, this same peculiarity is not shared by novocain. The dose of novocain may be safely fixed at one-third of a grain for a single injection. For dental purposes a one and one-half or a two per cent solution in combination with adrenalin has been injected without any ill results. For the purpose of confining the injected novocain to a given area, the addition of adrenalin in small doses, on account of its powerful vasoconstrictor action, is well adapted. It is the important factor which prevents the ready absorption of both drugs and consequently largely nullifies poisonous results. An injection of ten drops of a two per cent solution of novocain labially into the tissue produces a diffuse anesthesia lasting approximately twenty minutes; the same quantity, with the addition of one drop of adrenalin chlorid solution increases the anesthetic period to over one hour, and localizes the effect upon the injected area.

A suitable solution of novocain for dental purposes may be prepared as follows:

Novocain	10 grains
Sodium chlorid	4 grains
Distilled water	1 fluid ounce

Boil.

To each syringeful (2 c.c.) add one drop adrenalin chlorid solution when used.

A sterile solution may be made extemporaneously by dissolving the necessary amount of novocain-adrenalin in tablet form by boiling in

a given quantity of physiologic saline solution. A suitable tablet may be prepared as follows:

Novocain	1–3 grain
Synthetic suprarenin hydrochlorid	1–1200 grain

One tablet dissolved in sixteen drops of sterile physiologic saline solution makes a 2 per cent solution of novocain ready for immediate use.

Solutions for hypodermic purposes should be made fresh when needed. A simple porcelain crucible or a graduated porcelain dissolving cup held by a suitable twisted aluminum tongue and a dropping bottle constitute a simple outfit for this work. The dropping bottle should hold about 4 ounces and should be provided with a dust cap. A groove on one side of the neck of the bottle, and a vent on the other connected with two grooves in the back of the stopper allow the contents to flow drop by drop. A quarter turn of the stopper closes the bottle tightly. The number of drops present in each cubic centimeter differs with the various sizes of the dropping bottle, hence each bottle has to be standardized with a tested minim graduate or a tested burette. The standardized number may be marked on the respective bottles with a carborundum stone.

The Hypodermic Armamentarium.—A hypodermic syringe that answers all dental purposes equally well is an important factor in carrying out the correct technique of the injection. The injection into the dense gum tissue requires from 15 to 50, or even more, pounds of pressure as registered by an interposed dynamometer, while in pressure anesthesia 100 or more pounds are frequently applied.

The selection of a suitable hypodermic syringe is largely a matter of choice. All-glass syringes, glass barrel syringes, and all-metal syringes are the usual types found in the depots. After testing most of the dental hypodermic syringes offered in the dental depots within the last ten years by means of the pressure gauge and in clinical work, subjecting the syringes to a routine wear and tear, the author has found that the all-metal syringes of the "imperial" types are to be preferred over other makes. They are usually made of nickel-plated brass, which, however, is a disadvantage, as the nickel readily wears off from the piston, and exposes the easily corroded brass. The Manhattan all-metal platinoid syringe gives the best general service, and we can conscientiously recommend it to our confreres. The syringe holds 40 minims (2 c.c.), is provided with a strong finger cross-bar and is extremely simple in construction. The piston consists of a plain metal rod, without a thickened or ground piston-end or packing. The piston-rod is sufficiently long to allow about two inches of space between the cross-bar and the piston-top. This space is of importance, as it allows the last drop of

the fluid to be expelled under heavy pressure without tiring the fingers. The packing consists of leather washers inserted at the screw point, and are quickly removed and replaced if necessary.

The hypodermic syringe requires careful attention. It is not necessary to sterilize it by boiling after each use, unless it be contaminated with blood or pus. The simple repeated washings with alcohol and carefully drying is sufficient. The cap is readjusted, and the piston-rod is covered with a thin film of carbonated vaselin, or surgical lubricating jelly, and placed in position. If the syringe is boiled, all the washers must be removed. The syringe is kept in a covered glass or metal case, and a large bacteriologic Petri dish is suitable for this purpose. Leather-lined or felt-lined boxes afford breeding places for bacteria. Some operators prefer to constantly keep their syringes in an antiseptic solution when not in use, and others prefer to place them in a special sterilizing bottle, which bottles may now be purchased at dental depots.

Dental hypodermic needles should be made preferably of seamless steel, or, still better, of nickel steel, 22 to 24 B. & S. gauge, and provided with a short razor edge point. Thicker needles cause unnecessary pain, and thinner needles are liable to break. Iridioplatinum needles are preferred by some operators, as they may be readily sterilized in an open flame. The needle should measure from an inch to an inch and a half. For infiltration anesthesia one-inch needles are necessary, and curved needles of various shapes are essential in reaching the posterior part of the mouth. The "Schimmel" needles are excellent, but do not, however, fit every syringe. For pressure anesthesia special needles are required, and may be brought at the depots, or quickly prepared by grinding off the steel needle at its point of reinforcement. The sterile needles should be kept in well-protected glass containers. The needles are sterilized after each use by boiling in plain water, dried with the hot-air syringe, and immediately transferred to a covered sterile glass dish. The sterile needles should not be again touched with the fingers, and the customary wire insertion is unnecessary.

Technique of Injection.—Various methods of injecting the anesthetic solution about the teeth are in vogue. For the sake of convenience we may be permitted to divide them as follows:

1. Terminal anesthesia:
   - Subperiosteal injection.
   - Peridental injection.
2. Conduction anesthesia:
   - Injection at the infra-orbital foramen.
   - Injection at the maxillary tuberosity.
   - Injection at the incisive foramen.

Injection at the posterior palatine foramen.
Injection at the mandibular foramen.
Injection at the mental foramen.

3. Pulp anesthesia.

Before starting any surgical interference in the mouth, the field of operation should be thoroughly cleansed and sterilized by painting with diluted tincture of iodin. A serviceable dilution of the tincture for such purposes is made as follows:

Tincture of iodin (U. S. P.)	½ oz. (15 c.c.)
Diluted alcohol	1 oz. (30 c.c.)

Keep in a glass-stoppered bottle and apply with a cotton swab.

After the diagnosis is made the method of injection best suited for the case in hand is decided upon. The required quantity and concentration of the anesthetic solution is now prepared and the syringe and hypodermic needle fitted ready for the work. The correct position of the syringe in the hand of the operator and its proper manipulation are important factors which are acquired by practice. The hand holding the syringe is governed exclusively in its movement by the wrist, so as to allow delicate and steady movements, and the fingers must be trained to a highly developed sense of touch. The syringe is filled by drawing the solution up into it; it is held perpendicularly, point up, and the piston is pushed upward until the first drop appears at the needle point, which precaution prevents the injection of air into the tissues.

The Subperiosteal Injection.—The subperiosteal injection about the root of an anterior tooth is best started by inserting the needle midway between the gingival margin and the approximate location of the apex. The pain of the first puncture may be obviated by a fine, very sharp pointed needle, the simple compression of the gum tissue with the finger tip, by holding a pledget of cotton saturated with the prepared anesthetic solution on the gum tissue for a few moments, or by applying a very small drop of liquid phenol on the point of puncture. The needle opening faces the bone, the syringe is held in the right hand, at an acute angle with the long axis of the tooth, while the left hand holds the lip and cheek out of the way. After puncturing the mucosa, a drop of the liquid is at once deposited in the tissue, and the further injection is painless. Slowly and steadily the needle is forced through the gum tissue and periosteum along the alveolar bone toward the apex of the tooth, depositing the liquid under pressure close to the bone on its upward and return trip. The continuous slow moving of the needle prevents injecting into a vein. A second injection may be made by partially withdrawing the needle from the puncture and swinging the syringe anteriorly or posteriorly, as the case may be, from the first route of

the injection. This latter method is especially indicated in injecting the upper molars. After removing the needle, place the finger tip over the puncture and slightly massage the injected area. A circular elevation outlines the injected field. The naturally pink color of the gum will shortly change to a white anemic hue, indicating the physiologic action of the adrenalin on the circulation. No wheal should be raised by the fluid, as that would indicate superficial infiltration and consequently failure of the anesthetic.

As the liquid requires a definite length of time to pass through the bone lamina and to reach the nerves of the peridental membrane and the pulp, from five to ten minutes should be allowed before the extraction is started. The length of time depends on the density of the surrounding structure of the tooth. The progress of the anesthesia may be tested with a fine pointed probe, and its completeness indicates the time when the extraction should be started.

The upper eight anterior teeth usually require a labial injection only, while the molars require both a buccal and a palatine injection. Buccally the injection is made midway between the mesial and distal root, and on the palatine side over the palatine root.

The lower eight anterior teeth are comparatively easily reached by the injection. The straight needle is inserted near the apex of the tooth, the syringe is held in a more horizontal position and the injection proceeds now as outlined above.

The lower molars require a buccal and lingual injection. The curved needle is inserted midway between the roots, the gum margin, and the apices. The external and internal oblique lines materially hinder the ready penetration of the injected fluid, and therefore ample time should be allowed for its absorption.

If two or more adjacent teeth are to be removed, the injection by means of infiltrating the area of the gum fold directly over the apices of the teeth is to be preferred. It is advisable to use a one-inch needle for this purpose, holding the syringe in a horizontal position, so as to reach a larger field with a single injection.

The injection into inflamed tissue, into an abscess, and into phlegmonous infiltration about the teeth is to be avoided. The injection into engorged tissue is very painful; the dilated vessels quickly absorb cocain without producing a complete anesthesia, and generally poisoning may be the result. In purulent conditions the injection is decidedly dangerous, as it forces the infection beyond the line of demarcation. If the abscess presents a definite outline, the injection has to be made into the sound tissue surrounding the focus of infiltration. If a tooth is affected with acute diffuse or purulent pericementitis, a distal and a mesial injection

usually produce successful anesthesia by blocking the sensory nerve fibers in all directions.

Peridental Anesthesia.—Teeth or roots standing singly, or teeth affected by pyorrhea or similar chronic peridental disturbances, are frequently quickly and satisfactorily anesthetized by injecting the fluid directly into the peridental membrane. This method is known as peridental anesthesia, and its technique is very simple. In single-rooted teeth a fine and short hypodermic needle is inserted under the free margin of the gum or through the interdental papilla, into the peridental membrane between the tooth and the alveolar wall. Sometimes the needle may be forced through the thin alveolar bone so as to reach the peridental membrane direct. To gain access to this membrane in teeth set close together, separation is essential. It may be accomplished with an orange wood stick or by any of the various mechanical separators. By so doing, the body of the tooth is shifted to one side and thereby creating a slight space between it and the alveolar process. The injection is now made directly into the exposed peridental membrane. By reversing the separator, the tooth is shifted to the opposite side and the injected liquid is forced toward the apex of the tooth. A second injection is now made in this freshly exposed portion of the peridental membrane. Two, sometimes three, injections are necessary. To force the liquid into the peridental membrane usually requires a higher pressure than that which is necessary for injecting into the periosteum covering the alveolar process, but the quantity of the anesthetic fluid is less than that which is required for the former injection. Acute inflammatory conditions of the peridental membrane and its sequelæ prohibit the use of this method. Peridental anesthesia is the purest form of local anesthesia, since the seat of the nerve supply of the tooth is very quickly reached, and as a consequence the results obtained are in the majority of cases extremely satisfactory, provided that general conditions justify its application. The method is especially serviceable for the removal of pulps and in all cases where contact anesthesia is not indicated or for temporary desensitizing a tooth for operative procedures.

Intraosseous Injection.—To facilitate the passage of the injected fluid into the bone structure proper, Otté, in 1896, recommended a method by which he forces the anesthetic solution directly into the spongy cancelloid bone. Otté terms this procedure the intraosseous method of injection, and its technique is described by him as follows: After the gum tissue is thoroughly cleansed with an antiseptic solution, it is anesthetized about the neck of the tooth in the usual manner. After waiting two or three minutes, an opening is made into the gum tissue and the bone on the buccal

side with a fine spear drill or a Gates-Glidden drill. The opening should be made more or less at a right angle with the long axis of the tooth, a little below the apical foramen in single-rooted teeth or between the bifurcation in the molars. The right-angle hand piece is preferably employed for this purpose. The drill should be of the same diameter as the hypodermic needle. The gum fold is tightly stretched to avoid laceration from the rapidly revolving drill. As soon as the alveolar process is penetrated, a peculiar sensation conveyed to the guiding hand indicates that the alveolus proper is reached, and the sensation felt by the hand is about the same as that experienced when a burr enters into the pulp chamber. In this artificial canal the close fitting curved needle of the hypodermic syringe is now inserted, and the injection is made in the ordinary way. The quantity of fluid used is much less than is usually needed for a subperiosteal injection. The roots of the teeth are imbedded in a sieve-like mass of bone tissue (diplœ), which allows a ready penetration of fluid when injected under pressure. Very recently, Masselink advocates this method of the anesthetization of any tooth in the mouth either for the purpose of extracting or the removal of its pulp. He employs a No. ½ round burr for penetrating the alveolar plate and a very short needle (about $1/16$ of an inch) with a dull point for the injection.

Conduction Anesthesia.—For the anesthetization of a number of teeth in the upper or the lower jaw, conduction anesthesia by means of perineurial injection is preferably employed. The perineurial injection is made near the point of exit or entrance of the various nerves about their respective foramina. To anesthetize all the teeth of one-half of the upper jaw four injections are necessary, *i.e.*, two buccally and two on the palatine side of the bone. A one-inch needle is required for such work. To reach the many small branches of the posterior dental nerves at the alveolar foramina the injection is made buccally over the region of the tuberosity about one half inch above the gingival line between the first and second molar tooth. The second injection is made below the infraorbital foramen, so as to reach the middle and anterior dental nerves. With the index finger of the left hand the foramen is approximately located by exerting pressure upon the nerve-exit. The lip is lifted up with the middle finger of the same hand and the needle is now inserted between the apices of the canine and second incisor teeth. The needle is slowly pushed forward until its point is felt beneath the finger tip. To reach the nerve supply of the hard palate one injection is made near the posterior palatine canal, and the other near the foramina of Scarpa. The great palatine nerves pass through the posterior palatine canals on either side of the hard palate. The canals lie about three-eighths of an inch above the edge of the alveolar process and the last molar tooth. They move posteriorly with the erup-

tion of the successive teeth. The naso-palatine nerves pass through the foramina of Scarpa (incisive foramen) which are situated in the line of the suture of the maxillary bones. If an imaginary line is drawn from the distal borders of the two cuspids and passing over the hard palate, the line will ordinarily pass through the foramina. The needle should be inserted directly back of the papilla, which lies posteriorly between the central incisor teeth.

The successful anesthetization of the lower molars by the subperiosteal injection is frequently fraught with many difficulties on account of the heavy bony ridges on both sides of the teeth, which form strong barriers to the ready penetration of the solution into the bone. To overcome these difficulties Braun, in 1905, introduced a method, originally suggested by Halstead, in 1885, of centrally anesthetizing the mandibular and, incidentally, in many instances, the lingual nerve near the region of the mandibular foramen.

By palpating the surface of the ramus in the open mouth with the finger, the anterior sharp border of the coronoid process is easily felt about three-quarters of an inch posterior of the third molar. The process passes downward along the side of the last molar, and loses itself in the external oblique line. Mesially, from this ridge is to be found a small triangular concave fossa, which faces downward and outward, bounded lingually by the internal oblique line and covered with mucous membrane. As there is no anatomic name attached to this space, Braun has called it the retromolar triangle. Immediately back of the lingual border of this triangle, directly beneath the mucous membrane, lies the lingual nerve, and about three-eighths of an inch farther back the mandibular nerve. This last nerve lies close to the bone, and enters into the mandibular foramen which is located at the lower border of the mandibular sulcus and is partially covered by the mandibular spine or lingula.

Before starting the injection the patient should be cautioned to rest his head quietly on the head-rest of the chair, as any sudden movement or interference with the hand of the operator may be the cause of breaking the needle in the tissues.

The syringe is provided with a one and a half inch needle, held in a horizontal position and placed in the half open mouth across the tongue in the direction of the internal oblique line of the ramus. The needle opening faces the bone. The body of the syringe should rest between the cuspid, lateral incisor, or bicuspid, as the case may be. The thumb or the index finger of the left hand should be employed for palpating the retromolar triangle and the nail edge should be placed directly over the border of the internal oblique line. This point marks the place for the insertion of the needle. The beginner usually selects a point too far mesially. At

the moment of inserting the needle, the nail of the finger is withdrawn and the needle strikes the bone directly beneath the mucous membrane about one-half inch above the occluding surface of the last molar. The needle should be slowly advanced along the surface of the bone and at the same time the syringe should be swung gradually toward the other side of the mandible so as to rest upon the occluding surfaces of the teeth. The touch of the bony surface of the ramus which had been lost for a few moments, is again felt and the needle steadily advances in the direction of the mandibular spine. From now on, the touch with the bone must never be lost. About ½ c.c. of the anesthetic solution should be injected on its way to the sulcus and about 1½ c.c. deposited under steady backward and forward motion of the needle within the region of the mandibular fossa. From fifteen to twenty minutes are usually required for the anesthetization of the mandibular nerve. A slight infiltration of the gum tissue about the teeth to be operated upon insures a painless operation. Injection at the mandibular foramen is possibly only when the patient can open the mouth sufficiently to allow the ready introduction of the syringe. If the tissues about the third molar are infiltrated with inflammatory exudates, local anesthesia is absolutely prohibited.

Conduction anesthesia of the mandible is serviceable if a number of teeth are to be removed at one sitting. It should be borne in mind, however, that in general only one-half of either jaw should be anesthetized at one sitting, so as to keep the quantity of the injected anesthetic solution within the limits of ordinary dosage.

The mental foramen is usually located by exerting slight pressure near the apices of the first and second bicuspids upon the buccal surface of the mandible. The needle should be inserted in this region holding the syringe in a perpendicular position pointing downward. The finger tip should be placed over the foramen to act as a guide to the needle in its slightly forward and downward course. About ten to twelve drops should be injected and a slight pressure exerted by the finger which will assist in the passage through the foramen into the mandible.

Pulp Anesthesia.—By pressure anesthesia, pressure cataphoresis, or anesthesia, as the process is variously termed, we understand the introduction of a local anesthetizing agent in solution by mechanical means through the dentin into the pulp for the purpose of rendering this latter organ insensible to pain. Simple hand pressure with a suitable instrument, the hypodermic syringe or the so-called high pressure syringe, is recommended for such purposes. Regarding the principles of pressure anesthesia, it should be remembered that we cannot force a liquid through healthy dentin by a mechanical device without injury to the tooth itself. If a cocain solution is held in close contact with the protoplasmic fibers of

the dentin, the absorption of cocain takes place in accordance with the law of osmosis. The imbibition of the anesthetic is enhanced by employing a physiological salt solution as a vehicle. On the other hand, living protoplasm reacts unfavorably against the ready absorption of substances by osmosis for two reasons: (1) Its albumin molecule is relatively large and not easily diffusible, and (2) as an integral part of its life it possesses "vital" resistance toward foreign bodies. These latter factors are sufficiently demonstrated by the fact that it is very difficult to strain living tissue. Dehydration of the protoplasm increases the endosmosis of the anesthetic solution markedly.

When we apply the same "pressure" anesthesia upon carious dentin, the above statements do not hold good. We are able to press fluids quite readily through carious dentin. We must bear in mind that such dentin has been largely deprived of its inorganic salts, leaving an elastic spongy matrix in position. By drying out this dentin and then confining the anesthetic solution under a suitable water-tight cover, the pressure applied by the finger is quite sufficient to obtain the results. Colored fluids may be readily pressed through such dentin and even stain the pulp.

In teeth not fully calcified and in so-called soft teeth, pressure anesthesia is more readily obtained while, according to Zederbaum, the process fails in "teeth of old persons, teeth of inveterate tobacco chewers, worn, abraded and eroded teeth, teeth with extensive secondary calcified deposits, teeth whose pulp canals are obstructed by pulp nodules, teeth with metallic oxids in tubules, teeth with leaky old fillings, badly calcified teeth—mainly all from one and the same cause, namely, clogged tubuli. In most cases no amount of persistent pressure will prove successful."

From the foregoing it will be observed that the so-called high pressure syringes possess little merit relative to pressure anesthesia. The pressure which can be produced by a good working all-metal syringe, holding it between the index and middle fingers and forcing the piston with the thumb, amounts to 250 to 300 pounds in the average man. The pressure required in pressure anesthesia to produce a perfect contact is much less than the above force.

Methods of Anesthetizing the Pulp.—(1) The pulp is wholly or partially exposed. Isolate the tooth with the rubber dam and clean it with water and alcohol. Excavate the cavity as much as possible and if the pulp is not exposed, dehydrate with alcohol and hot air. Saturate a pledget of cotton or a piece of spunk with a concentrated cocain or novocain solution, place it into the prepared cavity and cover it with a piece of vulcanizable rubber and with a suitable burnisher apply slowly, increasing continuous pressure from one to three minutes. The pulp

may now be exposed and tested. If it is still sensitive, repeat the process. Loeffler states that "this pressure may be applied by taking a short piece of orange wood, fit it into the cavity as prepared, and direct the patient to bite down upon this with increasing force. In this way we can obtain a well-directed regulated force or pressure, and with less discomfort to the patient and operator." Miller described this process as follows: "after excavating the cavity as far as convenient and smoothing the borders of it, take an impression in modeling compound, endeavoring to get the margins of the cavity fairly well brought out; put a few threads of cotton into the cavity and saturate them thoroughly with a 5 to 10 per cent solution of cocain, cover this with a small bit of rubber dam, and then press the compound impression down upon it. We obtain thereby a perfect closure of the margin, so that the liquid cannot escape and one can then exert pressure with the thumb sufficient to press the solution into the dentin."

2. The pulp is covered with a thick layer of healthy dentin. With a very small spade drill bore through the enamel or direct into the dentin at a most convenient place, guiding the drill in the direction of the pulp chamber. Blow out the chips, dehydrate with alcohol and hot air, and apply the syringe provided with a special needle, making as nearly as possible a water-tight joint. Apply slow, continuous pressure for two or three minutes. With a round burr the pulp should now be exposed, and if still found sensitive, the process is to be repeated.

Recently a method has come into vogue which allows successful anesthetization of the pulp by injecting the anesthetic solution around the apex of the tooth. The spongy alveolar process, which contains lymph channels, allows the ready penetration of the fluid. The injection should be made close to the bone, pushing the needle slowly toward the apex, while the fluid is deposited drop by drop. No wheal should be raised by the injection, otherwise the benefits of the pressure from the dense gum tissue is lost.

According to Hertwig, the protoplasm of the cell primarily transfers irritation; and, secondly, transmits absorbed materials. Therefore, the anesthetic solution has to pass through the entire dentinal fiber because the nerve tissue of the pulp proper is reached. Consequently a certain period of time is required before the physiological effect of the anesthetic is manifested. This period of latency is dependent upon the thickness of the intermediate layer of dentin or bone. The successful anesthetization of the pulp depends largely upon this most important factor of allowing sufficient time for the proper migration and action of the drug.

The anesthetizing of the peridental membrane for the treatment of pyorrhea alveolaris is a comparatively simple matter if carried out

according to the methods as outlined under the heading of peridental anesthesia. Sometimes a topical application of a fairly concentrated novocain-adrenalin solution (about 10 per cent) and applied to the pockets by means of cotton ropes accomplishes the desired purpose. The surgical treatment of pyorrhea is materially simplified if the tissues under consideration are relieved of sensation.

Local anesthesia for operations about the mouth, exclusive of the extraction of teeth.

In operating about the mouth for an abscess, a cystic or a solid tumor of the approximate size of a large walnut, a malposed tooth, or for any other purpose, the rhomboid infiltration according to Hackenbruch affords the simplest means of producing a most satisfactory anesthesia. After previously cleansing the field of operation with an antiseptic solution, a very small drop of phenol is placed at the mucous membrane to superficially obtund the point of puncture. The needle is quickly thrust through the mucosa, and at once slow pressure is exerted on the piston, moving the needle steadily along the external line of the tumor. The needle is now partially withdrawn, without, however, leaving the original puncture, and a second injection or as many as may be needed are made in opposite directions. This maneuver is now repeated at a second point and thus a circumscribed infiltration of the whole tumor is obtained. If the tumor, etc., is very large, additional punctures and injections may be made as outlined in the schematic drawing. After ten to fifteen minutes' waiting the extirpation of the tumor may be begun. For injecting the soft tissues other than the gum a 1 per cent novocain—adrenalin solution—one tablet dissolved in 2 c.c. of water—is quite sufficient.

The anesthetization of the soft and hard palate is comparatively easily accomplished. The injection on the hard palate is started at the gingival edge of the alveolar periosteum on both sides of the jaw toward the median line. As the gum tissue is extremely dense, great force is required for a complete infiltration in this region, and only small quantities of the solution are required. The soft palate is easily infiltrated by inserting the curved needle posteriorly to the third molar.

Small tumors and cysts on the tongue or the floor of the mouth are best anesthetized by the rhomboid infiltration of Hackenbruch. For the complete extirpation of a ranula, the injection is made into the cyst wall near the periphery, after which the cyst is slit open and a small quantity of the anesthetic solution is injected into the inner surface of the cyst. Large cysts, tumors and major operations on the tongue require the anesthetization of both lingual nerves. In injecting and operating on the floor of the mouth, the index finger of the left hand should be placed on its external surface as a guide to the needle or the knife.

Local anesthesia is indicated in all minor and in relatively many major operations on the mucous surfaces, the skin, and the teeth. Local anesthesia is not a substitute for general anesthesia; its uselessness is materially increased by familiarizing one's self with the modern methods of its production and with a perfect mastering of the technique. The danger of poisoning has been practically eliminated by using isotonic solutions containing a relative small percentage of the anesthetic in combination with the alkaloid of the suprarenal capsule. Even if the danger of general necrosis is small under the very best conditions, the danger from local anesthesia is always less. The greater majority of all dental operations can be safely carried out under local anesthesia, provided the operator has acquired a complete working knowledge of the various components which, as a whole, constitute this important branch of dental therapeutics.

CHAPTER XXVI

THE EXTRACTION OF TEETH

P. G. PUTERBAUGH, M. D., D. D. S., F. A. C. D.

A proper understanding of the anatomy, histology, physiology and pathology of the teeth and their supporting structures is a pre-requisite to the study of the indications, contraindications, operative technique, etc. as related to the extraction of teeth. These subjects, as well as those of anesthesia and the removal of impacted lower third molars, are thoroughly presented in other chapters in this volume and need no further discussion here.

While the extraction of teeth is one of the oldest operations performed in surgery it has in the light of recent researches assumed a very important place in surgical practice. The elimination of infectious processes without undue sacrifice of healthy tissue, and the preparation of alveolar ridges that they may best serve the prosthodontist as a foundation for the support and retention of artificial dentures must be the constant aim of the exodontist of today.

With a more comprehensive understanding of metastatic dissemination of infection from local foci, the thought of both the dental and medical professions has been centered upon chronic infective processes occurring about the apices of teeth, as well as those primarily involving the gingival margin. Although the author does not intend to enter into a lengthy discussion of the various infective processes that are productive of serious systemic complications, he is of the opinion that since most of the chronic type of infections involving serous membranes, such as the synovial membranes lining joint cavities, are of the non-purulent streptococcus viridans group that it is only by hearty coöperation between the dental and medical professions that the best interests of our patients are to be conserved.

One must bear in mind also that in this type of infection there are no local symptoms manifest unless the site becomes involved with pyogenic bacteria as well. Bone destruction is slow and the infected area is filled with a granulomatous mass of tissue containing a comparatively small amount of clear serum-like fluid.

In the light of our present knowledge it would seem advisable to secure a set of good dental radiograms in all suspected cases as the first step in

determining the extent of pathologic processes occurring about the teeth. This is then to be checked up by a thorough oral examination by the dentist and the final decision as to the disposition of many cases must necessarily be reserved until a conference is had with the physician relative to the general condition of the patient's health. Acute abscesses and chronic ones with discharging sinuses are easily diagnosed without the radiogram. The decision as to whether or not a tooth may be successfully treated and filled must necessarily rest with the individual practitioner, but the ruthless extraction of all teeth presenting with exposed pulps is to be condemned.

Indications for Extraction of Teeth.—Those teeth whose supporting tissues are so weakened by disease that their usefulness is lost and all teeth with pericemental or periapical infections whose retention prevents the complete eradication of the disease should be removed from the mouth. It is likewise advisable to extract all teeth so situated that their retention would interfere with the proper insertion of artificial dentures. To relieve patients with impacted or imbedded teeth that form foci for infection or are causative factors in neuralgia, reflex pain or mental diseases, the offending members demand elimination.

Those teeth which are crowded completely out of the arch and where orthodontic treatment is contraindicated should be removed in order to prevent dental caries and pyorrhea due to faulty contacts, as likewise all teeth demanding elimination for orthodontic purposes.

Deciduous teeth which interfere with the normal eruption of their permanent successors, and supernumerary teeth having a tendency to interfere with the arrangement of the permanent dentition, proper enunciation in speech, or oral hygiene are to be extracted.

Teeth through which broaches or other foreign irritating materials have been forced into the periapical tissues, the removal of which is contraindicated by the trans-alveolar route, are useless to retain in the mouth.

Those teeth whose pulps have been destroyed before calcification of the roots has sufficiently well advanced to justify an attempt at root canal fillings, and teeth forming nuclei for cysts, epuli, or other tumorous formations are to be eliminated.

Contraindications to Extraction of Teeth.—We should postpone the extraction of teeth involved in well developed alveolar abscesses when fluctuation is present and where the shortest route through which to evacuate the pus is by an incision in the gum. In such cases it is preferable to evacuate the contents of the abscess cavity at once and to delay the extraction of the offending tooth until after the acute inflammatory symptoms have subsided.

Teeth, which are firmly attached in their sockets and occurring in the line of fracture of the mandible are to be retained in position until after

reduction has been accomplished and the reparative process well under way when they may be removed if they then interfere with proper union.

The presence of acute ulcerous gingivitis or any acute ulcerative process involving the oral tissues is very prone to spread to the alveolar sockets following extraction and may induce severe secondary hemorrhage or alveolar necrosis.

Patients suffering from trifacial neuralgia frequently demand the extraction of teeth showing no evidence of disease. Extraction in such cases is to be refused for experience has taught us that the relief following extraction in such cases is negligible and if obtained at all is of extremely short duration.

Deciduous cuspids should never be removed to make room for the eruption of the permanent lateral incisors, indeed one should never extract a deciduous tooth for the purpose of assisting in the eruption of any permanent tooth excepting its proper successor.

Pregnancy, lactation and menstruation are contraindications to all surgical operations unless acute symptoms demand relief from pain and toxemia.

Defective teeth demanding ultimate extraction but not causing local or systemic symptoms in the presence of either of the above conditions, should have their removal deferred until a later date. If, however, one or more teeth are the seat of pain and cannot be made comfortable by palliative measures, extraction is indicated at once and is less likely to be followed by disagreeable symptoms than if the patient be allowed to continue in pain. Likewise, exhausting fevers and debilitating diseases, nervous affections, etc. present problems that must be decided only after careful consideration and consultation by the dentist and attending physician.

In the operator's demeanor toward the patient I am pleased to quote Dr. F. J. S. Gorgas in the previous editions of this work, who says:

"Under normal conditions, and if performed on scientific principles, tooth-extraction is not a difficult operation; although cases are sometimes met with, where, owing to abnormal conditions, the operation requires considerable judgment and skill, severely trying the patience of the operator and the endurance of the patient. It is therefore difficult to formulate special rules which may be literally followed. The axiom, which is an established rule in all surgical procedures, that every operation is performed quick enough that is performed well, is particularly applicable to tooth-extraction. A kind manner and a tender regard for the physical and mental suffering of the patients, on the part of the operator, will, in the majority of cases, so impress them, that they will quietly submit to his judgment and skill. It is well never to promise more than it is probable

can be performed; and in the case of children, to adhere to the truth, for deception may render a first operation easy of accomplishment, but will react in the case of a second one, and leave such unhappy impressions upon the mind that years cannot entirely efface.

"Excessive solicitude should also be avoided upon the part of the operator, and in all cases patience and gentleness should be exercised. The unnecessary display of instruments, together with the preparation of them in the presence of the patient, should also be avoided.

"While it is true that the most expressive lamentations by the patient do not invariably indicate acute suffering, yet there are other cases where no outward manifestations of pain may be exhibited, and at the same time the effect on the nervous system be such as to severely tax the vital energy. Hence it is better not to exact too much of a nervous patient, who may heroically nerve herself to quietly endure intense suffering, and show no visible signs of agony."

The preliminary examination of the tooth or teeth to be extracted should be performed in a thorough and careful manner, noting the general condition of the mucous membrane, the extent of decay, the firmness with which the tooth is attached in its socket and ascertaining if it is held between the approximating teeth so as to interfere with its removal. The amount of abrasion on occlusal surfaces and the general muscular development of the patient will often give a clue as to the probable resistance that the tooth will offer during its extraction. One should consider the necessity of supporting the mandible and decide upon the proper method of so doing when indicated.

Loose bridges, crowns and plates and eyeglasses if worn should be removed. Radiograms should always be secured of impacted and imbedded teeth before attempting their removal for it is impossible to properly map out a plan of procedure without so doing.

Instrumentarium.—From the large array of forceps and elevators displayed in the dental supply houses we may, with a little care, select an outfit consisting of six forceps and three elevators that will meet the requirements of almost any case that may present itself for extraction. Multiplicity of forms is not only unnecessary to the experienced operator, but is confusing to the beginner and it is the writer's opinion that a high degree of skill developed in the use of a few instruments is preferable to the possession of a bewildering variety of forms with which the operator has only a slight acquaintance.

In choosing instruments, certain fundamental principles should not be ignored. The ends of the beaks of forceps must be thin in order that they may be forced sub-gingivally to a sufficient depth that a firm grasp be obtained on root surfaces without tearing or otherwise mutilating the

gingival margin. The beaks must converge enough that when the tooth is grasped the compression will be at the ends of the beaks on the root surfaces without impinging on the coronal portion of the tooth; if beaks are parallel, fracture of the crowns of teeth is inevitable. The ends of the beaks must not be too far from the joint of the instrument else a secure and firm grasp upon the tooth will be impossible. Beaks should bear such relation to the handles of the instrument that in their application they will grasp the tooth in the direction of its long axis, and their size and shape should conform to that of the tooth to be extracted. Fine shallow serrations parallel with the beaks are permissible but the tendency at present is to choose instruments with smooth beaks. Deep cross serrations are unsanitary, of no value and are to be condemned. Handles, joints and beaks must be rigid under any pressure to which they are to be subjected, yet light enough to insure delicacy of touch. The blades of elevators must be sharp and delicate in order to insure their application without apparent roughness on the part of the operator, and they should be fashioned from the finest steel obtainable. Elevator handles are of either the large straight hexagonal or octagonal variety affording a comfortable firm palm grasp, or of the cross bar type. The straight handle is preferred by the majority of men because it is more readily applied and kept under control by the operator of average experience.

Extraction movements may, for convenience, be divided into three groups. Firstly, there is the application of the beaks of the forceps in such a manner that a firm grasp upon the root of the tooth is obtained, well under the crest of alveolar process. By doing this a considerable amount of pericemental attachment is severed, thereby facilitating the execution of subsequent procedures. Secondly, the application of force designed to sever the remaining pericemental attachment and to expand the orifice of the alveolar socket sufficiently to permit the delivery of the tooth from its socket. The forces employed are rotation upon the long axis of the tooth; buccal, lingual, mesial or distal tipping. Thirdly, the removal of the loosened tooth from its socket by traction.

Each movement should be executed slowly and with care as to the amount of force exerted in order that unnecessary damage to the tooth that is being removed, the adjacent teeth, or the supporting structures, be avoided.

Position of the Patient and Operator.—The patient is seated comfortably in an upright or slightly reclining posture with the chair placed in its lowest position. For the removal of the ten upper anterior teeth and the left upper molars the operator stands to the right and slightly in the rear of the chair. The left arm encircles the patient's head holding it firmly in position in the head rest; the fingers of the left hand serve

as retractors for the lips and cheeks, thereby affording an unobstructed view of the field of operation. Counter pressure exerted with the remaining fingers upon the teeth of the upper arch is also of great assistance in stabilizing the patient's head during the execution of the various extraction movements with forceps or elevators. The patient's head is rotated to the right for the convenience of the operator, while operating upon the left bicuspid and molar area, and to the left for the extraction of the right bicuspids. For operating upon the right molars the operator stands to the right of the chair facing the patient; the left thumb and fingers serving as cheek retractors and assisting during the execution of extraction movements by producing counter pressure. The arm is elevated just enough so that the cheek may be retracted without obstructing the view of the operator.

A chair capable of being lowered to within sixteen inches from the seat to the floor is desirable because a very low position of the patient is necessary in order to keep the force exerted in operating entirely under the control of the operator. Much unnecessary mutilation of the supporting tissues has resulted at the hands of inexperienced operators who have failed to observe this precaution. In case a low chair is not available the operator may overcome the difficulty by standing upon a small platform or foot stool.

Preparation of the Field of Operation.—The crowns of all teeth and the mucous membrane in the field of operation are first swabbed with plain gauze for the purpose of freeing them of debris and mucous accumulation that may be adherent to them. Tincture of iodin is then applied to the part in order to fix the remaining bacteria and to prevent the carrying of actively infectious material into the deeper tissues during the application of the forceps.

The Upper Central Incisor.—This tooth has a single conical root averaging one half inch in length which is slightly flattened on the labial, mesial and distal surfaces; it is not liable to fracture unless weakened by caries or the excessive reaming of the root canal for the reception of a crown post.

Holding forceps No. 150 in the right hand, the beaks are separated just widely enough to admit of their being adjusted to the root. The lingual beak is applied first between the tooth and the free gingival fold, then the labial beak is adjusted in a similar manner, and while grasping the handles lightly the lingual and labial beaks are alternately forced by a rotating motion well under the gum until they are firmly seated against the alveolar crest. The handles are now grasped firmly and moderate labial force exerted; this severs some of the pericemental fibers on its lingual aspect. The handles of the forceps are carried ling-

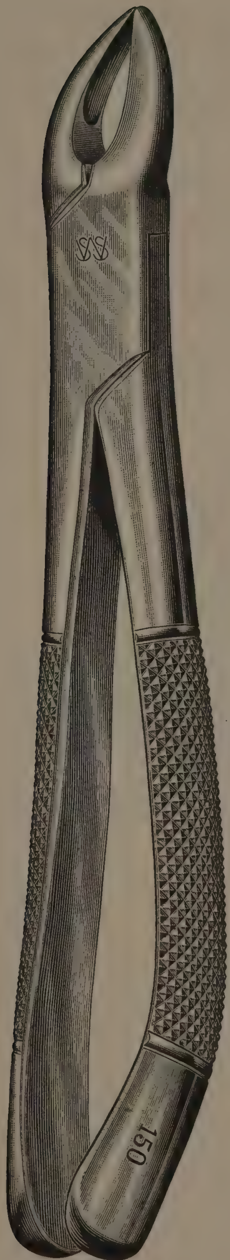


FIG. 301.—No. 150. Universal Incisor, Cuspid, Bicuspid and Root, Upper.

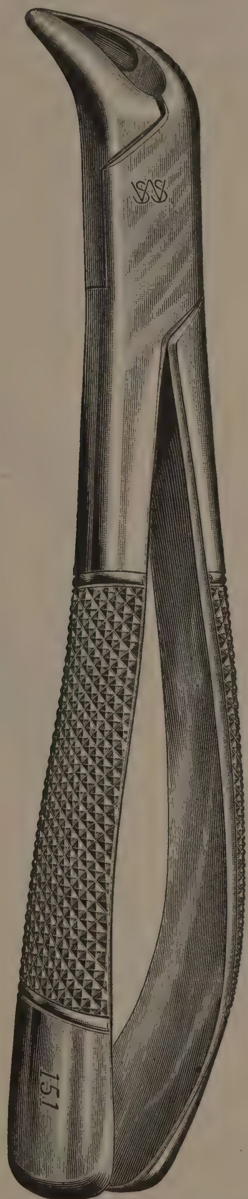


FIG. 302.—No. 151. Universal Incisor, Cuspid, Bicuspid and Root, Lower.

ually, weakening the fibrous attachment on the labial surface of the root. Returning the tooth to its original position, it is now rotated to the mesial and with slight traction removed from its socket.

The Upper Lateral Incisor is slightly longer than that of the upper central and differs markedly from it in form; being decidedly more flattened on its mesial and distal surfaces. This coupled with the fact that it frequently has a decided distal curve at the apex precludes the possibility of rotating it in its socket.

With the patient and operator in the same position as indicated for the extraction of the upper centrals, forceps No. 150 is applied. After placing the lingual beak, the labial is applied and both are forced deeply under the alveolar crest in order to grasp the root as near the apex as

FIG. 303.

possible and thus minimize the danger of possible fracture. Grasping the handles firmly, the tooth is carried bodily to the labial; this is followed by the application of force to the lingual; these movements are repeated carefully in order to prevent fracture of the frail root, until the tooth is loosened when it may be removed from its socket by means of slight traction.

The Upper Cuspid.—This tooth owing to its size, shape and length of root and the unusual strain to which it is subjected during the process of mastication, is very firmly fixed in its socket and is likely to require considerable effort to effect its removal.

In the application of forceps No. 150 the beaks must be forced deeply under the alveolar crest on the labial and lingual surfaces. Alternate labial and lingual application of force is applied with the greater force toward the labial. In case this fails to sever the attachment combined rotation and lingual, followed by rotation and labial force is attempted,

the rotation being in a mesial direction in order to avoid fracture of the tip of the root in case, as frequently occurs, it is curved to the disto-lingual.

Traction is of little value until the fibrous pericemental attachment has been well broken down. In case the execution of the movements outlined fails to dislodge the tooth, the forceps must be reapplied more deeply under the alveolar crest, grasping the root nearer the apex and the movements above outlined, repeated.

The Upper First and Second Bicuspids.—With the patient and operator in position as outlined, forceps No. 150 is applied as for the anterior teeth, *i. e.* the lingual beak first, then the buccal beak, both of which must be seated deeply against the alveolar crest grasping the root firmly well above the coronal portion of the tooth. The labial and lingual plates of alveolar process in this location are both yielding, therefore force is applied alternately in buccal and lingual directions until the alveolus is expanded and the pericemental attachment broken when slight traction following the line of least resistance will remove the tooth from the socket. Fully one half of the first bicuspids have two roots and, as these are quite slender, care must be taken against excessive tipping, either to the buccal or lingual, in order to avoid fracturing one or both roots. The second bicuspid root is often somewhat cylindrical in form and its removal is seldom attended with difficulty when it is normally placed. (Fig. 303.)

The Upper Molars, because of their similarity in form and location will be considered together. With the patient and the operator in position as outlined, the upper molar forceps No. 18R or No. 18L, as the case may be, is applied with the smooth beak to the lingual root and the pronged beak to the buccal surface; the single prong fitting into the bifurcation between the buccal roots.

Deep application of the beaks is essential to the correct adaptation of their surfaces to the tooth. Firmly grasping the handles steady traction in a decidedly buccal direction is executed; this is followed by lingual traction in a lesser degree using care to avoid fracture of the lingual root. Repeating these movements with moderate traction, following the line of least resistance always, the thin alveolar process at the orifice of the socket will expand under the wedging action until it will permit of the delivery of teeth with widely divergent roots without fracture of either the tooth or process.

Upper molars are not of uniform size or shape and anomalies are often encountered, but if the operation be not hurried and the line of force diverted toward the avenue of least resistance when force is applied in various directions little difficulty should be experienced in their removal.

Upper third molars are often inclined decidedly toward the cheek, but their removal is readily accomplished by tipping them out in a disto-

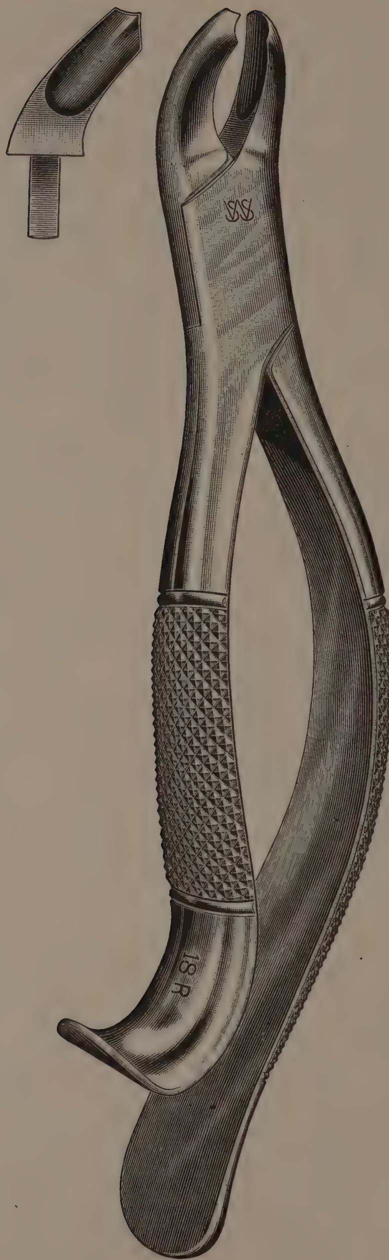


FIG. 304.—No. 18R. Molar, Upper Right Side.

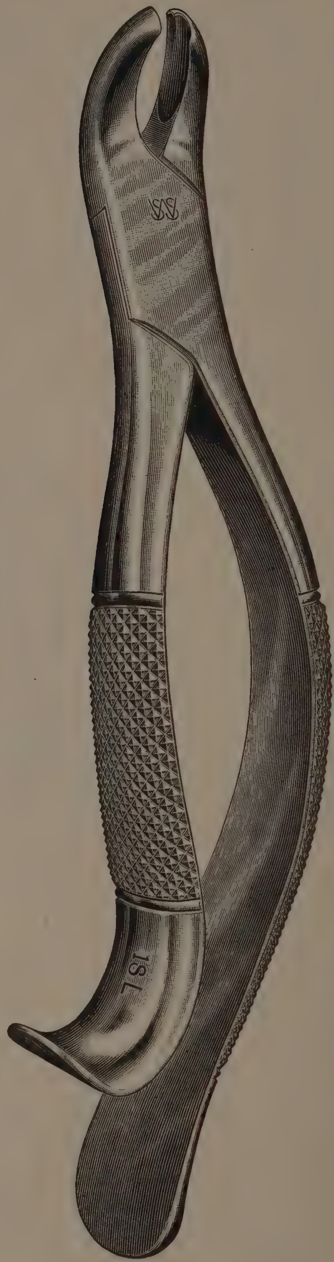


FIG. 305.—No. 18L. Molar, Upper Left Side.

buccal direction; in case the application of forceps is difficult in the buccally displaced third molar a Cryer elevator inserted between it and the second molar and rotated slightly will effect the extraction without mutilation of tissues. Care should be taken to avoid so great an amount of force in a distal direction that would result in fracture of the maxillary tuberosity.

Extraction of Teeth in the Lower Arch.—The removal of teeth from the mandible is attended with more difficulty than those in the maxilla. The mandible is not a fixed bone in the skeleton and especially under general anesthesia must be supported by the operator during the execution of extraction movements. Fig. 306. The tongue and buccal tissues often interfere with the adjustment of forceps and elevators, and blood and saliva accumulate, thereby obscuring the operator's view of the field of

FIG. 306.

operation. A frequent accident is the dislodgment of crowns or fillings, or of fracture of upper teeth with the forceps due to the sudden release of a lower tooth while strong traction is being exerted, in an upward direction.

Position of Patient and Operator for Extracting Lower Teeth.—When nitrous oxide anesthesia is employed, an upright position of the patient is always preferred in order to prevent the dropping of tooth fragments and the gravitation of saliva and blood into the respiratory passages. Under local or conductive anesthesia slight backward tilting of the chair is permissible and often affords a more comfortable posture for the operator and secures a better view of the field of operation; this is especially true in extracting mandibular teeth on the left side and of incisors and cuspids.

The chair is placed in its lowest position and the operator's position is at the right of the patient. In operating upon the anterior teeth and left bicuspids and molars, the operator's left arm encircles the patient's head, holding it firmly in position in the head rest while the left hand grasps

and stabilizes the mandible exerting counter pressure to antagonize the extraction movements. This relieves the patient of much distress and prevents dislocations of the temporo-mandibular articulation. In operating upon the right mandibular bicuspids and molars the operator faces the patient and stabilizes the mandible from in front by grasping it in the left hand with the thumb on the occlusal surfaces of the teeth and the fingers under the lower border.

Lower incisors are so narrow in their mesio-distal diameter that a very narrow beaked forceps is selected to avoid the accidental removal of more than one tooth at a time. In case the regular forceps No. 151 is not readily adjusted, as occurs occasionally when the teeth are overlapped and crowded in the arch, the upper bayonet root forceps No. 65 applied while the operator stands directly behind the patient with the chair tilted well back and the regular extraction movements executed. On account of the delicacy of the roots, care must be exercised against the exertion of undue force and their resultant fracture. The lingual beak of the forceps is placed first, then the labial is adjusted, carefully avoiding the inclusion of gum under the beaks; alternate labial and lingual tipping force is cautiously applied with the greater inclination toward the thin labial plate of alveolar process, until the socket is expanded and the attachment severed, when the tooth is delivered from the socket in the line of its long axis.

The Lower Cuspid is removed in much the same manner as the lower incisors with the exception that a great deal more force is required in severing its attachment. The root is not nearly so flattened mesio-distally and is therefore less liable to fracture; in fact rotation is frequently resorted to in breaking up its attachment, especially when the labial plate of process is firmly attached and adheres to the tooth after the lingual attachment has been severed.

The lower bicuspids are centrally placed between heavy buccal and lingual alveolar plates, both of which are quite unyielding to pressure. The roots are over half an inch in length, conical and nearly straight. When present at all, curvatures are in the apical third and are to the distal. Lower bicuspids have a decided general inclination to the lingual and in applying forceps the lingual beak is adjusted first, being careful to avoid the inclusion of gum under the beak, the labial beak as placed last and the forceps carried well apically until a firm grasp is obtained.

The forces applied are lingual, buccal and rotation in the order named; rotation being most effective but should follow the expansion of the socket by the previous lingual and buccal applications of force. These teeth are frequently subject to excementosis and when so involved may resist all efforts of extraction until the alveolar process is cut away sufficiently with a bur to allow the delivery of the bulbous root end.

The lower molars have two roots, the mesial one broad bucco-lingually and flattened mesio-distally. The distal root is conical in form. They have a general curvature and inclination in a distal direction. The first molar roots are usually separated by a thick septum of alveolar process and are larger and more constant in form than those of the second and third molars. The roots of the second molar are not so curved or divergent and are often fused together forming a single root. The third molar is subject to the greatest number of variations in form, multiple roots with extreme apical curvature toward the distal being the most frequent anomaly encountered.

The buccal and lingual alveolar plates are quite firm and often require the application of considerable force in order to compress them enough during the execution of extraction movements to permit of the severing of their attachment and of delivering the tooth. The lingual plate, however, thins down in the second and third molar areas and will usually yield more readily than the buccal plate.

Universal lower molar forceps No. 17 is now carefully adjusted so that the small prongs on the beaks engage the tooth in the bifurcation. Care must be exercised in the application of the blades in order to avoid driving them distally and engaging also the tooth posterior to the one to be extracted.

The extraction movements are limited to the buccal and lingual directions and should be accompanied by moderate traction. They should be slowly executed and should follow the line of least resistance; the latter being difficult to determine if the extraction movements are rapid. Failure to observe caution will result in the unnecessary fracture of many roots. Frequently roots are fractured due to haste after they have been detached when the exercise of a little care and patience would have expanded the socket sufficiently to allow of their delivery intact.

With the first and second molars in position, the third molar should be first loosened with a LeCluse elevator, then delivered with forceps if necessary. This elevator is applied as a wedge below the contact point between the second and third molars, the flattened side approximating the third molar. The first movement is to tip the upper border of the blade distally, forcing the third molar backward and severing its attachment on the mesial surface. This is followed by rotation of the blade in a reverse direction in which the lower edge engages the mesial surface of the third molar under the gingival margin, elevating the tooth in its socket when it may usually be removed with forceps with little effort.

Elevators are essentially levers and their application demands a suitable fulcrum from which the power may be transmitted to the tooth or root to be extracted. When two or more adjoining teeth are in contact the one approximating the tooth to be extracted may serve as a fulcrum as in the

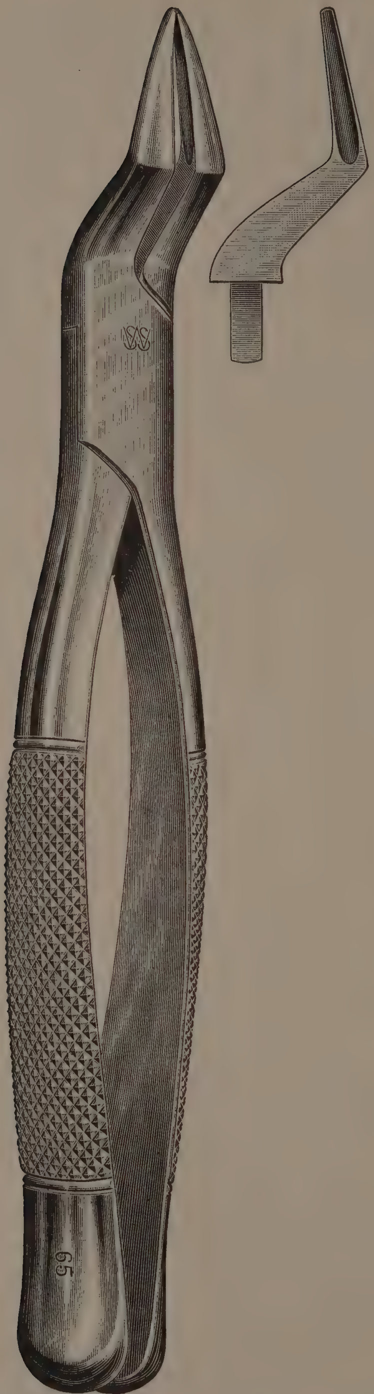
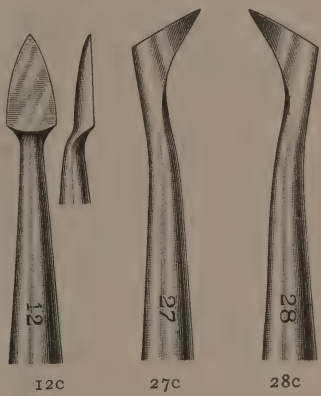


FIG. 307.—No. 65. Root, Upper. Bayonet Shape Slender Beaks.

FIG. 308.—No. 17. Molar, Lower Either Side.

extraction of many lower third molars. In cases where molar roots have been separated by decay the elevator blade may be inserted between them and one root made to serve as a fulcrum and when it in turn is to be removed the alveolar process of the empty adjacent socket will form the fulcrum for the remaining root. Bicuspid and incisor roots can oftentimes be removed with less laceration of the soft tissues if an elevator instead of forceps is employed. The elevator is especially indicated here when the entire crowns have been lost as the result of dental caries. Figs. 309, 310, 311.

Owing to the fact that elevators are capable of exerting a great deal of force it is imperative that they be constructed of the best steel obtainable in order that the operator be not annoyed by bending or breakage of the instrument. Handles should be of the large hexagonal or octagonal type and so shaped that they may be held comfortably in the palm grasp. The cross bar type of handle is preferred by some operators of experience but because of the comparative ease with which tremendous power is exerted they are not to be placed in the hands of inexperienced operators without a word of caution against the possibility of fractures of the jaws resulting from their careless application.



FIGS. 309, 310, 311.—Elevators.

In those cases where decay has extended through the bifurcation of roots in molars the remaining root fragments can often be grasped individually with thin narrow beaked root forceps and with slight rotation or buccal and lingual tipping be delivered from their sockets. Where the gum overlaps the root, however, the elevator is indicated; the blade of a Cryer type of instrument is inserted deeply between the roots and using one as a fulcrum a slight rotation of the handle will deliver one; then the reverse instrument is applied in the empty alveolus and the root formerly used as a fulcrum is elevated, using the alveolar process as the fulcrum.

Hemorrhage.—Hemorrhage, following extraction of teeth, is to be expected and will, in most instances, arrest itself within ten or fifteen minutes by the formation of a firm clot in the socket. This will not only effectually occlude the bleeding vessels but will seal out foreign matter while new capillary loops are proliferating and organization taking place in the deep portion of the wound.

Persistent and excessive hemorrhage may result from a deficiency in the coagulating elements of the patient's blood; or it may result from the severing or opening of one or more small arteries from which the blood will spurt with so much force that it will dislodge the coagulum before it has time to become firm enough to withstand the pressure.

Topical applications applied for the purpose of hastening hemostasis are known as styptics. Small gauze sponges wrung out of boiling water and pressed into the bleeding socket are very effective. Monsel's solution (Liquor Ferri Subsulphatis U. S. P.) applied on gauze is the best chemical agent for dental use. Adrenalin Chlorid may serve temporarily but rarely will secure permanent results.

The great secret in controlling persistent hemorrhage following an extraction is in first thoroughly removing all clot formation from the socket with tweezers, cleaning it out thoroughly before attempting to pack, then pack with a strip of gauze beginning at the bottom of the socket and packing full; then bringing firm pressure to bear upon this with the finger for five or ten minutes. In nearly all instances plain gauze will

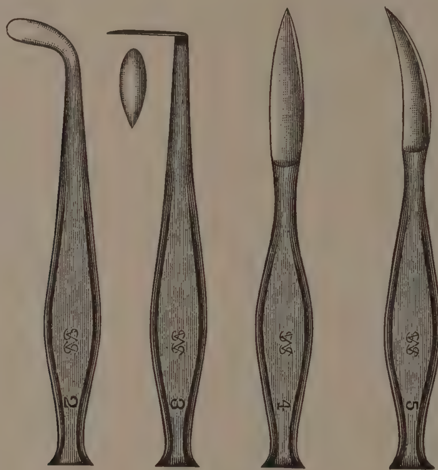


FIG. 312.

suffice; in obstinate cases the gauze should be moistened with Monsel's solution and packed as above outlined. This dressing should be left for twenty-four hours and a new one reapplied at that time if necessary.

Various other means have been employed, such as the taking of an impression with plaster of paris or modelling composition in a crown and bridge tray, leaving the impression in place for several hours. The plugging of sockets with cork plugs, the placing of a rubber dam clamp on an adjacent tooth and packing gauze in the bleeding socket to be retained by the bow of the clamp which extends over the site of extraction; the use of such styptics as tannic acid or glycerite of tannin, phenol, silver nitrate, zinc chlorid, starch, etc.

Blood should form a firm coagulum in from four to eight minutes and in case the coagulating time exceeds this greatly it may be hastened by supplying the deficient elements by the administration of 100 c.c. of

normal horse serum. (If this is unobtainable, diphtheria antitoxin will do instead.) Resort to this expedient is rarely practiced for the control of hemorrhage due to extraction of teeth as the intelligent application of styptics produce results that are eminently satisfactory.

A suitably shaped sharp gum lancet is needed at all times. When operating under local anesthesia it is passed alongside the tooth or root to be extracted severing the gingival attachment to the tooth, down to the alveolar crest, thereby assisting in the adjustment of forceps and assuring the patient of the painlessness of the procedure to follow. When division of gum is indicated in order to remove teeth or roots, a clean cut incision with a lancet is to be preferred to mutilation with forceps or elevators. Occasionally the soft tissues will cling to a loosened tooth and require severing with a lancet in order to prevent extensive laceration that would otherwise ensue if further attempts to extract be continued. It is employed also for incising gum overlying imbedded and impacted teeth prior to their removal. Fig. 312.

Malposed Teeth.—Teeth situated outside the proper alignment of the arch are usually extracted with root forceps, grasping them on their mesial and distal surfaces. Considerable caution must be exercised to avoid their fracture or the dislodgment of one of the approximating teeth.

When the tooth is in such position that it is difficult to grasp with the forceps a Cryer elevator is inserted between the teeth under the gingival margin and using the adjacent tooth and alveolar crest as a fulcrum elevates and delivers the tooth from its socket.

Impacted upper cuspids are removed in two ways. In the event that the teeth against which the impaction occurs are defective because of alveolar abscesses or of root absorption brought about by the pressure of the erupting tooth, they are extracted their sockets enlarged with fissure burs and sufficient bone removed from around the cuspid to permit it to be loosened with an elevator and the crown grasped with forceps.

In case the teeth in place are sound and the cuspid lying near the palatal mucosa, an incision is made one eighth of an inch to the lingual of the teeth extending from the central incisor to the second bicuspid. The soft tissues are elevated from the bone, and the alveolar process overlying the imbedded tooth removed with chisels or burs sufficiently to secure good exposure when the cuspid is elevated from its bed with Cryer elevators. The wound is cleansed carefully and the flap sutured in place by two or three horsehair sutures. Union of the flap by first intention is the rule, the sutures being removed in five days.

Occasional cases present where the apex of an imbedded anterior tooth is palpable from the labial surface and the radiogram discloses the crown lying in the palate. Such teeth are removed through a horizontal labial

incision, care being exercised to avoid injury to the adjacent teeth while burring the bone away in order to permit their removal.

Impactions of any tooth may and do occur, but it is not within the scope of this chapter to deal exhaustively with so complex a subject, and the interested reader is referred to books dealing particularly with that subject.

Curettement following the removal of teeth is indicated in those instances where granulomata, large abscesses or cysts lie beyond the apices and do not adhere to the teeth sufficiently to come away at the time of their extraction. The mass of soft tissue to be removed is readily scooped out in nearly all instances by passing a curet down through the socket. Occasionally the socket affords inadequate access for thorough curettement in which case a counter opening is made from the labial surface. A horizontal incision 1 cm. in length is made over the apex, the periosteum elevated with a chisel and the cavity entered with a round bur. Curettement through this opening may then be readily performed.

When several adjacent teeth are removed at one time the healing process can be materially hastened by removing the sharp alevolar septal and labial crests at the time of extraction. To do this satisfactorily local or conductive anesthesia is required; after the teeth have been extracted and any periapical areas cared for by curettement the labial gum is elevated from the sharp alveolar crests and the latter removed with alveolar cutting forceps or small rongeurs. Suturing of the flaps is seldom necessary but horsehair sutures may be employed if needed to hold the gum flaps in contact with the alveolar process. Complete approximation of the edges of the gum is unnecessary. Teeth affected by pyorrhea are not difficult to extract and their sockets require no further treatment of any kind.

The extraction of deciduous teeth differs in no way from that of the permanent ones with one exception and that is that the operator must ever bear in mind that a permanent tooth germ lies under each deciduous tooth and that violent extraction movements may produce injury to the permanent tooth; or high application of forceps may extract both the deciduous tooth and its permanent successor at one operation.

Accidents.—Unforeseen complications and accidents will be experienced from time to time and will often call for quick action and resourcefulness to meet them properly. If trouble is anticipated the patient should be warned of the danger before the operation is begun; then he will not be so ready to blame the operator as he might otherwise be. Some of the more commonly experienced ones follow:

Excementosis may be so extensive that the removal of the apex of the root through the socket becomes a physical impossibility. When this condition is encountered the orifice of the socket is enlarged with burs until sufficient space is gained to permit the delivery of the root.

Fracture of teeth and roots are likely to occur in teeth supporting dowel crowns and in those whose pulps have long been devitalized. When fracture occurs resort is had to root forceps which are forced between the gum and alveolar process, cutting through the latter and securing a firm grasp upon the root; or to elevators the blades of which are forced alongside the root and extraction performed by elevation.

Fainting.—Not infrequently patients exhibit signs of syncope following extraction of teeth. This is especially prone to occur in individuals suffering from alveolar abscess. When the signs of uneasiness, airhunger, paleness about the lips, cold perspiration and general weakness indicate that syncope is imminent, the chair is tilted back until the patient is in a nearly horizontal position. Ether is poured upon a napkin and administered by inhalation; if ether is not at hand, ammonia water may be substituted. When complete recovery is delayed one half teaspoonful of aromatic spirits of ammonia in a wineglass of water administered internally will in nearly all cases revive the patient enough so that the operation may be completed.

The extraction of an adjacent tooth is an unavoidable accident when two teeth are fused together, but should not otherwise occur.

A tooth may be easily forced into the maxillary sinus if it be the seat of a chronic dento-alveolar abscess; this is usually accomplished by not separating the beaks of the forceps widely enough to embrace the root when attempting to grasp the tooth with forceps. When this accident does occur, the socket is enlarged in a buccal direction and the root removed from the maxillary sinus with tweezers.

A tooth may be forced into the buccal, lingual or pharyngeal tissues by elevators or forceps. A radiogram is necessary for their localization, and this serves as a guide for their removal.

Teeth may slip from the forceps and be drawn into the trachea during inspiration and lodge in one of the bronchi. They must be removed with forceps under bronchoscopy else a fatal lung abscess will develop.

Injury to other teeth by striking them with forceps, or to bridges or crowns on adjacent teeth are avoidable accidents and should not be permitted to occur.

The bruising of cheeks and lips and pinching them with forceps are avoidable if proper care is exercised on the part of the operator. Hot fomentations will assist in caring for bruises. Lacerations should be touched with tincture of iodin and a mouth wash prescribed. Wounds of the tongue and floor of the mouth are rarely serious unless an artery is severed in which case resort to ligation may be necessary. Patients receiving deep punctured wounds produced by elevators should have a prophylactic dose of tetanus antitoxin in addition to the local treatment.

Dislocation of the temporo-mandibular articulation occurs in extract-

ing teeth from the lower jaw when traction is produced without providing support for the mandible. When this accident does occur it should be reduced immediately in which case no more serious consequences than local soreness during mastication for a few days are likely to follow.

Fracture of the maxilla or mandible during extraction is very uncommon but does sometimes occur. It may be due to fragitalis ossium, a pathologic condition in which all of the bony tissues become extremely brittle, or it may result from weakness of the bone produced by infections, cysts, imbedded or impacted teeth or neoplasms. For treatment of fractures the reader is referred to the standard works on Oral Surgery.

Fracture of the maxillary tuberosity, removing a large portion of the antral floor, sometimes happens during the extraction of upper second and third molars. When it occurs the fractured portion is removed if freely movable, preserving as much of the soft tissue as is possible. The antrum is packed lightly with gauze to prevent hemorrhage and food accumulation the dressing being changed daily for one week, after which time the dressings are discontinued. These wounds heal without complication.

Green stick fractures of labial or lingual plates of alveolar process with gum attached to the fragments simply require being pressed back to place by squeezing the wound between the operator's thumb and finger.

Exposed alveolar process, denuded of gum tissue, should be removed with cutting forceps, curets or burs.

Osteitis and osteomyetitis occur in infected sockets and in others when a firm blood clot fails to form, leaving the walls of the alveolus bare and exposed to the oral fluids. It is the cause of the so-called after pain so frequently noted following extractions. The treatment consists in first irrigating the socket with warm boric acid solution, absorbing excess moisture with gauze and applying a gauze dressing moistened with a 15 per cent solution of procain in essential oils, marketed under the name of "Novesthol;" camphophenique; or "Euroform Paste (Buckley)." These dressings are allowed to remain twenty-four hours at the end of which time they are removed.

Of all agents suggested for internal medication for the relief of pain following operations upon the jaws, the author has secured greater satisfaction from the administration of pyramidon in five grain doses every two hours then from any other drug. Opium derivatives such as morphin, codein and heroin have their advocates, as have acentanilid, acetphenetidin, acetyl salicylic acid, salicin, etc., and may with propriety be employed.

Hot fomentations are applied externally and afford much comfort assisting quite materially in the relief of pain and in promoting free circulation to the inflamed tissues.

CHAPTER XXVII

THE LOWER THIRD MOLAR

BY C. EDMUND KELLS, D. D. S.

THE LOWER THIRD MOLAR

General Considerations.—In view of the most unfortunate and far reaching effects produced upon the patient by lower third molars, frequently, when their presence is not even suspected, these teeth become of paramount importance to the dentist, the physician, and *incidentally* to the patient as well.

Melancholia, hysteria, mania and dementia precox (whatever that may be) have all, in many cases, been traced to unerupted or impacted third molars, and cured by their removal.

Unless a dentist has something better upon the subject than "Insomnia and Nerve Strain" (Henry S. Upton, M. D.) upon his shelves, a copy of this book should be there; and moreover he should be familiar with its contents.

It must always be borne in mind that the pain from an impacted or unerupted third molar is never localized in the region of the tooth itself, and that is why they are so frequently unsuspected.

Intolerable earache is not infrequently caused by unerupted lower third molars, whether they are impacted or not. In Fig. 313 is shown a skiagraph of a case, in my own practice, of a "misplaced" lower third molar which had a most interesting history, and one well worth recording right here, as it illustrates most fully the seriousness of this subject.

A young woman,—possibly thirty years old—living in a good sized town, developed slight trouble in her left ear. In the beginning, the earache was only occasional, but it soon became more intense and the paroxysms more frequent until—to use her own words to me—"I almost go crazy, and when one of these spells comes on, I feel as if I want to kill some one." By this time her general health had naturally been badly shattered, and, as her local physician could do nothing for her, she was sent down here to one of our sanitariums. Immediately upon entering the hospital, skull pictures were taken, which disclosed three unerupted third molars, and I was called in consultation.

Upon examining the plates, both unerupted upper and lower third molars upon the right side were to be seen, but the lower one was not impacted—merely misplaced. Notwithstanding that the upper molar was impacted, there was no pain in the right ear. Upon the left side there was no upper third molar, and the lower one was anything but impacted—it was very much misplaced, which is clearly shown in the picture.

Upon general principles, it was probably safe to say that this lower molar could cause the trouble, and, therefore, its removal was advised.

When the patient was brought to the office, an intra oral picture was taken for a working basis, and then the cause of her trouble was clearly disclosed, for on this film quite a large cyst was to be seen enveloping the root end, and undoubtedly this pressed upon the inferior dental nerve. Immediately following the removal of this tooth, the patient returned to "normalcy."

Fig. 313.

Another symptom of an impacted lower molar is severe pain in the back of the head, sometimes extending onto the neck, and sometimes pain in the frontal region.

With such grave conditions resulting from these molars, it is not to be wondered that they now receive so much consideration, and that the removal of some such deeply embedded molars is considered a *major operation* by those who are in a position to know whereof they speak.

The mere fact that the presence of an impacted lower third molar has been disclosed by the ray, does not mean that if that tooth is removed, the patient's troubles—that is, if the patient is suffering—will be eradicated.

As before stated, the impacted tooth practically never causes local trouble, but it is invariably manifested in some other region.

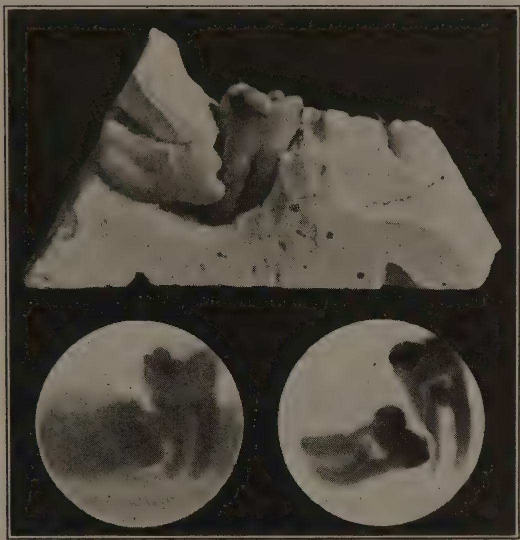
Now then, if a patient presents with an impacted molar which has burrowed its way into the second molar to such an extent that the pulp of the second molar has become exposed or nearly so, then, under these conditions, the cause of the pain is the exposure of the pulp in the second molar, and, consequently, the removal of the third molar will not relieve the pain. When, therefore, it is decided that these conditions exist, then the second molar itself must be extracted, and in a case like that shown in Fig. 314, there is no advantage in leaving the third molar in the jaw, and, therefore, it too should be removed.

Such a case illustrates the necessity of early diagnosis and removal of impacted third molars before they can injure perfectly good and useful second molars.

When, on the other hand, a case presents in which the second molar has been either badly injured by the third molar or badly broken down and in bad condition generally, and the third molar stands at an angle of 45°

A

B



C

B C

FIG. 314.—*A*, Model showing teeth as the stood in the mouth. *B*, Skiagraph taken before extraction. *C*, *Shadowgraph* showing the absorption of the second molar.

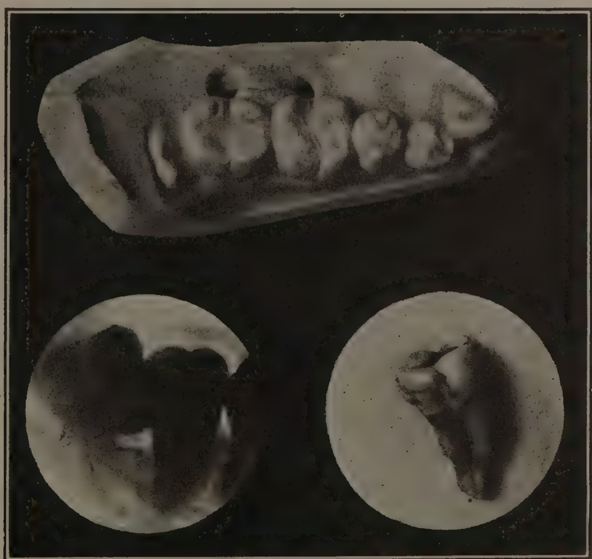


FIG. 31.

or more, then that second molar should be extracted and the third molar allowed to remain, whereupon it may, in time, erupt and become a good and useful tooth.

In Fig. 315 is shown such a case. The pulp of the molar was exposed where in contact with the cusp of the impacted tooth, and had caused the patient intense suffering.

The second molar was removed and the third molar allowed to remain, and in time it came into almost a vertical position and became a useful tooth.

Rules of Practice.—When a boy or girl reaches the age of twenty-two or twenty-three, and the third molars have not erupted, the regions are always rayed.

If the molars are found to be impacted, their early removal is advised. If found misplaced, or unerupted, but vertical, then the patients are advised about as follows:

"These teeth are evidently not doing you any harm at present, and, therefore, they need not be removed. If, at any future time, any untoward symptoms develop, and the cause cannot be ascertained, then remember these unerupted teeth and act accordingly."

Patients are now under observation who are over forty years of age, and have unerupted third molars which have thus far never produced any visible bad results. It is held to be good practice never to inflict an unnecessary operation upon a patient.

Treatment of Adults.—When an adult stranger presents just as an ordinary patient and with the third molars missing, about the first question asked is the history of these teeth. If the patient remembers positively having had them taken out, no further consideration is given them, but if he hesitates at all about the history, I say, "I am particularly interested in unerupted third molars, and I would appreciate your allowing me to take some pictures just to see whether or not yours are hidden under the gum." Under these conditions, no charge is made for these skiagraphs. However, it is not infrequent that, under just these conditions, one or more unerupted or impacted molars are to be found. If they are found impacted, then I advise that something be done, but just what, depends, of course, upon the conditions found.

If any are found unerupted or misplaced, then I question the patient about his history. If he is perfectly well and free from pain, etc., I do not urge their removal, but if the patient has any pain, the cause of which is not apparent, then would their removal be advised.

General Classifications.—When speaking of unerupted lower third molars, when the time for their eruption is past due, most, if not all, operators call them "impacted." However, as all unerupted lower third molars do not hold the same relative positions to the second molars, let us stop and consider whether or not all such unerupted teeth can properly be called *impacted*.

Webster's New International Dictionary defines the word "impacted" as "driven together or close"—"forcible contact." In view of the fact that all unerupted teeth are either "driven together or close" to, or in "forcible contact" with, the normal bone which surrounds them, it would hardly seem appropriate to term an unerupted lower third molar "impacted" unless it was in *forcible contact* with something other than its

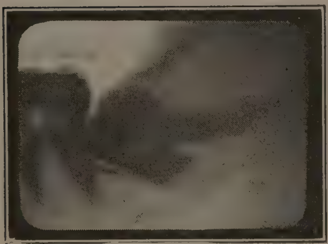


FIG. 316A.

FIG. 316B.

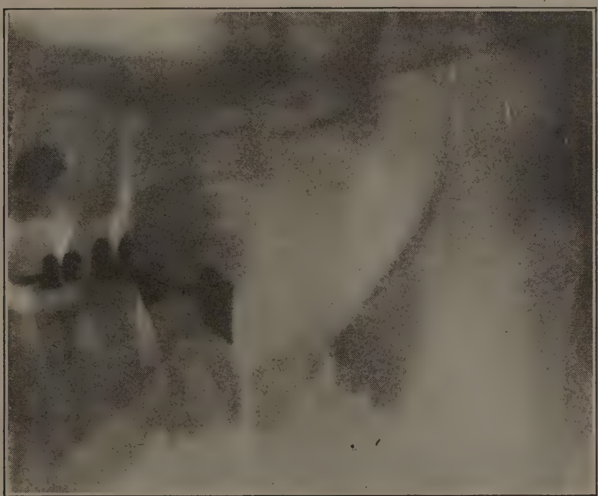


FIG. 316C.

normal surrounding bone, and that could only be in "forcible contact" with the second molar. Therefore it is that the following classifications of unerupted lower third molars have been offered by me.

(A) Impacted: When they are in "forcible contact" with the second molar.

(B) Unerupted: When they *are in* their normal vertical positions, but, for some unknown reason, their eruption has been delayed.

(C) Misplaced: When they *are not in* their normal positions, and yet are not impacted.

These several classifications are represented in Fig. 316, and each class must be considered individually.

At B is shown what might well be termed a noble specimen of an unerupted tooth. An impression of the jaw was taken before the tooth was removed, and the tooth itself was set in the plaster model in the position it originally held in the jaw.

Another form of impaction is shown in Fig. 317.

Here the third molar is in a vertical position, and yet thoroughly impacted under the overhanging crown of the second molar, and it never can erupt. Such a tooth should be removed before it has had the opportunity to injure the second molar—and right here it might be well to state that just such innocent looking teeth are sometimes most valiant "*contenders*."

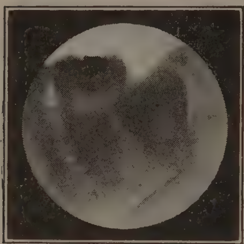


FIG. 317.

Special Classifications.—Impacted lower third molars, as here classified, may, themselves, be again divided into two classes:

1. In which the distal cusp, only, of the third molar has erupted and is plainly visible, while the mesial cusp is firmly locked under the convexity of the crown of the second molar; and

2. In which no part of the third molar has erupted and its presence and position are only discovered by means of the radiogram.

Class 1. *Treatment.*—As a rule, an impacted third molar of class one is not brought to the operator for attention until the patient has been suffering for some time, and when presenting, the probabilities are that the mouth cannot be opened to any extent, and there is more or less inflammation; and yet that same patient, intelligent though he may be, will expect to have that tooth "pulled" at once, and painlessly at that.

Did these conditions obtain upon any other part of the body, the patient would undoubtedly be put to bed—possibly in a hospital—and, therefore, there is no reason why the dentist should not be entitled to some consideration in such cases, and, consequently, be allowed to refuse to operate until conditions become more favorable.

Undoubtedly, in an extreme case, it might be advisable to administer ether, forcibly open the jaws and remove the tooth; but, fortunately, such cases are rarely met with, and it might well be possible that the after effects of such rough treatment might be more harmful in the end than if a milder course had been pursued.

If, therefore, a patient presents, who is unable to open the mouth, one

should first adopt every possible means for reducing the local inflammation by the use of poultices and warm lotions within the mouth, and sometimes leeching might be advisable. Antiphlogistine should be applied to the face and neck, supplemented, when advisable, by the use of anodynes, while the nourishment of the patient must be given careful consideration, and the elimination specially attended to.

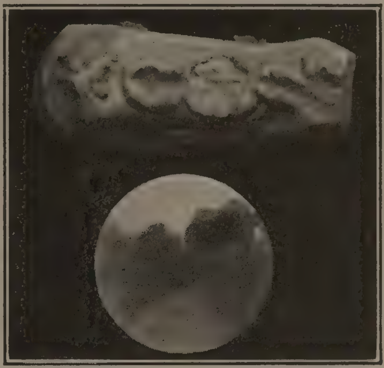


Fig. 318.

Under this treatment, the patient should soon be free from pain and conditions should improve more or less rapidly; and as soon as the mouth can be opened sufficiently wide,—and not before—the tooth should be removed.

Naturally, when, upon presentation, the patient can open the mouth sufficiently wide, the operation is not thus delayed.

In Fig. 318 is shown a typical case of this class.

Class 2. In Fig. 319 is shown a typical case of Class two.

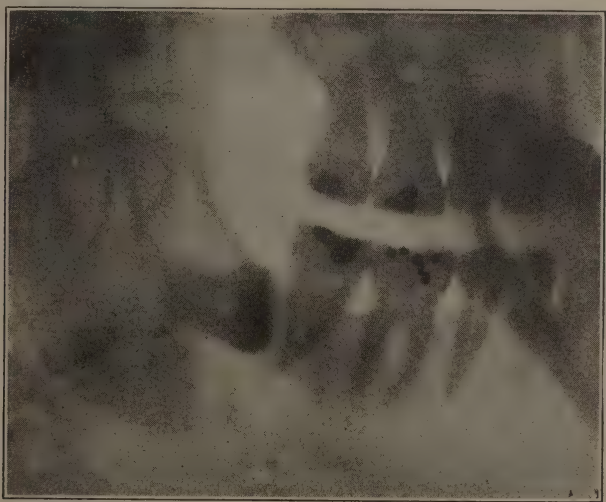


Fig. 319.

Here the entire tooth is deeply embedded, and the patient has no reason to suspect its presence, as, if it causes trouble, it can only be through the *reflexes*.

However, before going further, let us study the conditions as they present in Fig. 320. Here is shown a typical impacted tooth. If the *crown*

of this tooth is to be raised vertically, the tooth must be rotated upon its long axis "A" Fig. 320.

Placing a pair of dividers upon the sketch, one point at "B" and the other at "C" and striking the segment of a circle, the curved line "D" represents the path through which the point of the cusp must travel during the procedure of being *raised.*

It is very evident from this diagram that such a molar, wedged in as it is, cannot be removed, *as found*, by means of an elevator or forceps without breaking either the third molar itself or badly fracturing the overlapping crown of the second molar. Such being the case, other methods must be followed.

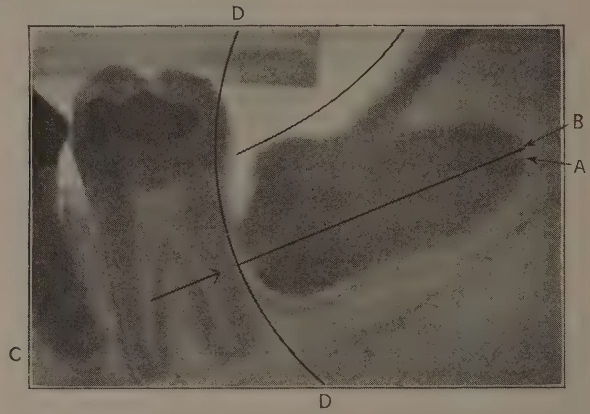


Fig. 320.

Stages of the Operation.—The operation for the removal of impacted lower third molars may well be considered to consist of two stages—the operative stage, usually a painless one; and the post-operative stage, which will be either one of comparative comfort, or one of much suffering and discomfort; and it is undoubtedly due to the *technique* used, and the care with which, the operation itself is performed, as to which of these results will follow.

Operations for the Removal of Impacted Molars.—It is believed that there are to-day three methods of dealing with such refractory molars:

1. The extracting of the second molar first, whether that tooth be good, bad or indifferent, after which the removal of the third molar would be more or less easy, according to its position. This is probably an old, and the original, operation.

2. The removal, by means of the mallet and chisel, of enough of the bone overlying and *buccally* to the tooth so as to allow of its extrusion.

3. The cutting of the tooth in two and removing each part separately.

The Original Method.—The extraction of good and useful molars, in order to facilitate the removal of impacted third molars, should never be practiced except as a last resort. In Fig. 321 is shown one of the most extreme cases ever met with.

It was simply impossible to reach this deeply placed crown without cutting away a dangerous amount of bone, and so a perfectly good second molar was very reluctantly sacrificed. Even then the third molar was removed with great difficulty.

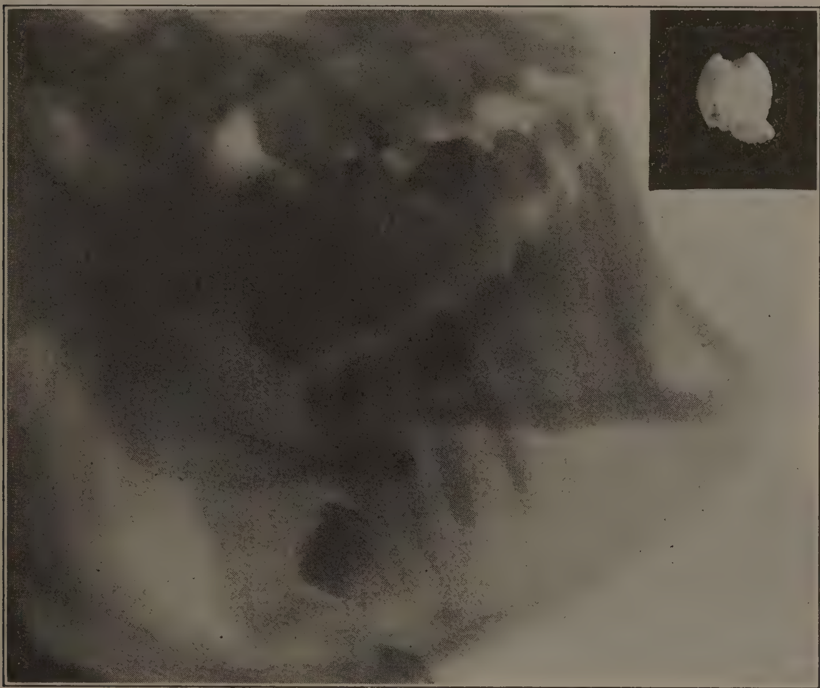


FIG. 321.

The Mallet and Chisel.—In carrying out this operation, it must be borne in mind that there is absolutely no *give* to either the second molar or to the impacted tooth, and not very much to such dense bone as surrounds it. Therefore it stands to reason that an immense amount (comparatively) of bone must be cut away, as shown in Fig. 320, in order to allow the extrusion of the tooth.

The result of so much cutting is naturally a very extensive wound, and, in addition thereto, all of the consequences that would naturally result from such a severe operation. As a matter of fact, most of the prominent oral surgeons who follow this technique, tacitly admit its severity by insisting upon performing it in a hospital, and many of them insist upon ether as the anesthetic.

The definition of the word "hospital" is: "A place where the sick or injured are given medical or surgical care." Therefore it is self-evident that when a dentist takes his patient to a hospital for the removal of a tooth, he naturally believes that when *he* gets through with *him*, that patient will be one of the "sick and injured," and, therefore, will need medical care. If such really is the case, then the hospital should naturally be the place of choice for that dentist.

Owing to what is believed to be the unnecessary severity of the operation, and the very serious post-operative stage which invariably follows it, and not being desirous of availing myself of the advantages of a hospital, I have never yet removed such a tooth by this method.

It is, however, undoubtedly safe to say that this operation is a comparatively rapid one and quite easy—if you will. All that is necessary—and that *is* necessary—is to *have the heart* to chisel away enough of the bone to release the tooth, and then by means of suitable elevators and considerable force, remove the tooth.

To witness such an operation,—referring to a deeply embedded molar—at a clinic, is most interesting, but to see the patient the following day is usually more instructive. The advocates of the mallet and chisel method say that the chisel makes a clean cut wound, while burs lacerate the tissues; consequently the wound caused by the chisel will heal more quickly than one made by the bur.

This, it is granted, is true, provided ragged edges caused by the bur are left in the wound, but these ragged edges may be made nice and smooth, fully equal, if not superior, to those of the chisel; consequently, that argument is of no value.

Again, while a *clean cut* can be made with a chisel, it is just as easy—if not easier—to make a very ragged cut with a chisel. It depends entirely upon who is using the chisel.

Postulates.—For the surgical removal of impacted, unerupted or misplaced lower third molars (or any other teeth for that matter) the following postulates are offered:

1. Trauma must be *minimized.*
2. Laceration of the soft parts must be minimized.
3. Cutting away of the bone must be minimized.
4. Surgical and mechanical shock must be minimized.
5. Only the purest and freshest of anesthetic solutions must be used.
6. The mouth must be thoroughly cleansed.
7. The operative field must be well sterilized.
8. Surgical asepsis must be maintained *as far as possible.*

The Operation of Choice.—It is believed that the operation that is now to be described fully meets the above postulates, and it is also now believed

that whenever post-operative pain does occur, it is due to one or more of the following reasons:

1. First and foremost, it is believed that the heat, caused by cutting with engine burs through the dense enamel and dentin or even bone, will cause post-operative pain.

2. Ragged edges of the socket will irritate the overlying soft tissues and cause severe pain.

3. Splintering of the walls of the socket will result in small particles exfoliating later on, and these sometimes give trouble.

4. Undue laceration of the soft tissues gives trouble.

In the operation as originally practiced, the tooth was cut in two in its natural field, under which conditions the cutting instrument generated an intense heat, and undoubtedly this intense heat caused post-operative pain in many cases.

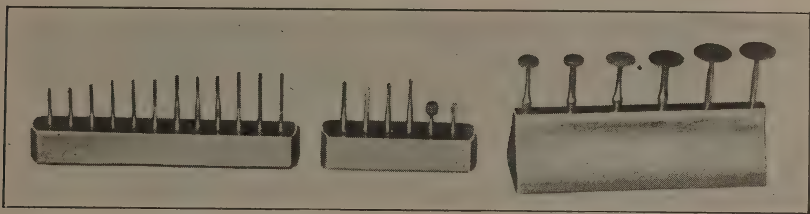


FIG. 322.

Upon reaching this conclusion, an apparatus, by means of which the tooth and cutting instrument could be maintained absolutely *cold*, was immediately devised; and since the introduction of this method, the post-operative results have been absolutely revolutionized.

Original Devices.—Upon originating an operation, and frequently as one proceeds with his ordinary work, one finds that the instruments and appliances that are available, and which were designed by some one else, do not appear to be exactly suited to the work in question, and, therefore, others must be designed. Under these conditions, and with the hopes of accomplishing better results, the following instruments and appliances were devised.

Instrument Racks.—These little racks made of brass and nickel plated—are found to be most satisfactory for holding instruments. Racks and instruments can be sterilized together by any desired method. Fig. 322.

Wedges.—These are readily made of ordinary *tool steel*, to be obtained of almost any diameter desired, and which can be purchased by the foot. (Fig. 323.)

Flap Holders.—These are almost instantaneous products of the laboratory. A piece of one quarter inch copper tubing is slotted at both

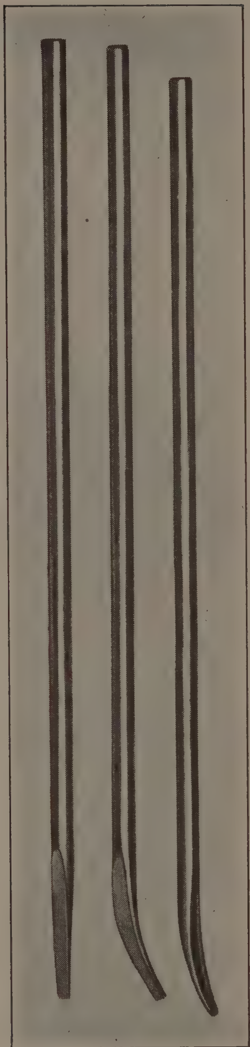


Fig. 323.

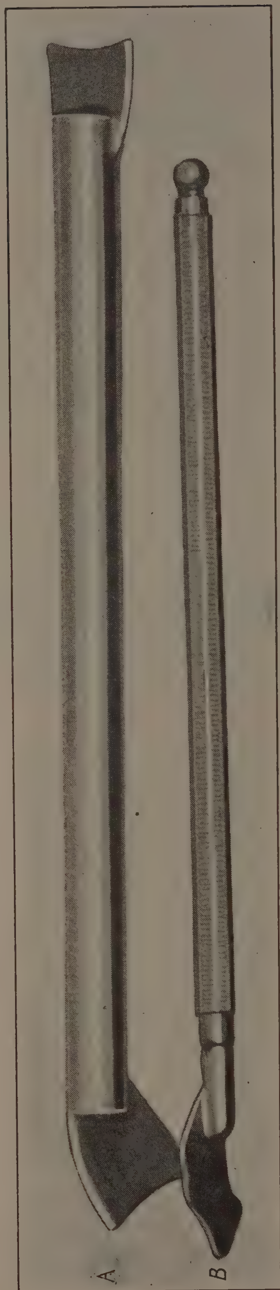


Fig. 324.

ends by means of a hack saw; pieces of sheet copper or brass, twenty-six or twenty-eight B. and S., are cut into the shapes shown, adjusted into the slots and soldered. Fig. 324 A. An old instrument handle is slotted and a piece of sheet copper soldered in. Fig. 324 B.

Mouth Props.—Every metal mouth prop ever seen had a way of following the *opening movement of the jaw and locking there*, a most serious disadvantage, it would appear.

With ordinary brass bolts, spring brass wire and sheet brass, the mouth props shown in Fig. 325 were made in a very few moments, and they are very satisfactory.

Two points of advantage they possess: The one, that they can be adjusted while in the mouth by running the adjusting nut up or down; and the other, that they do not hold the jaw in a fixed position.

Those are *the* features of these props. Take an ordinary metal

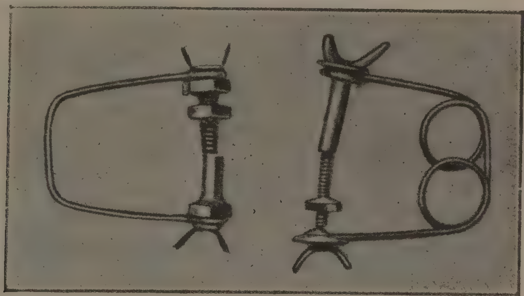


FIG. 325.

prop and place it in position. The patient can neither open nor close the mouth the least bit. The lower jaw is held immovably. That is most fatiguing. With this prop adjusted to keep the mouth open a certain distance, the patient can first open and then close the mouth a little, and the prop will follow the movement. This possible movement of the jaw is a great relief to the patient.

To use: Fill the cups with sufficient softened modeling compound, place in position and let the patient close down upon them and chill. The teeth sink into the compound and it gives them a soft cushion. Any one can make these props with very little trouble; or possibly may improve upon them.

Knives.—The knives here shown have proven very satisfactory and are indispensable to the accomplishment of the character of work now done. The handles are the ordinary S. S. White contra angle porte polishers. These individual blades were made by the *Stellite* people, to patterns furnished, and are really beautiful instruments. Attached as they are to the contra-angle handpieces, they can easily reach any part of the

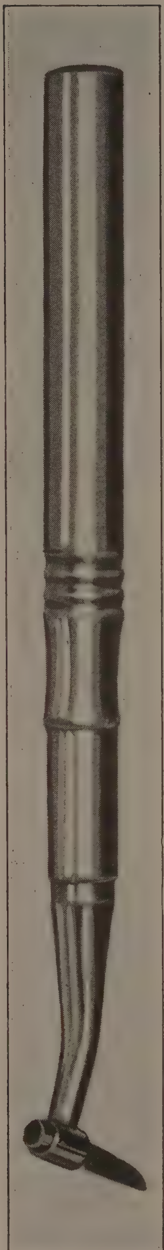


FIG. 326A.

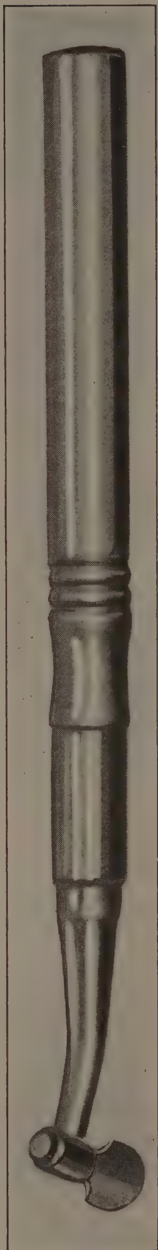


FIG. 326B.

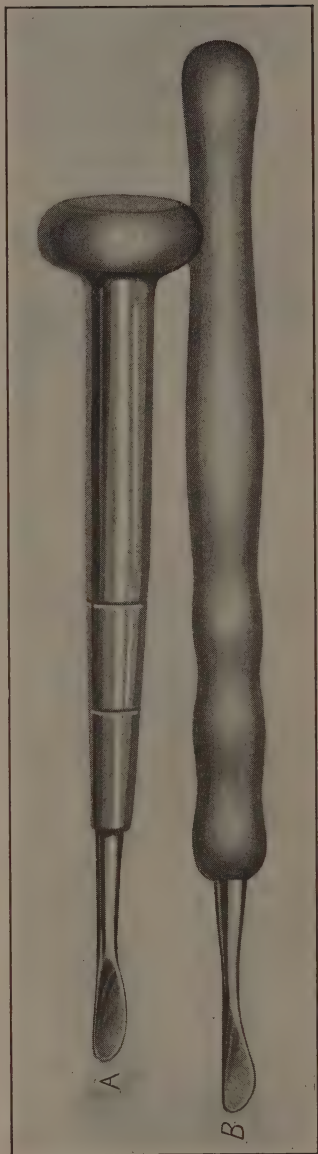


FIG. 327.—A, Kingsley scraper with handle made of brass telescopic tubing and cast tin knob. B, Kingsley scraper with aluminum handle. Edges of scrapers well rounded.

mouth, and, rotating as they do, they can be adjusted so as to cut in any desired direction. (Fig. 326.)

Periosteotome.—All periosteotomes listed in the catalogs of the leading instrument makers proved impossible in my hands, so the ones shown in Fig. 327 were made and have proven most satisfactory.

Fig. 328.

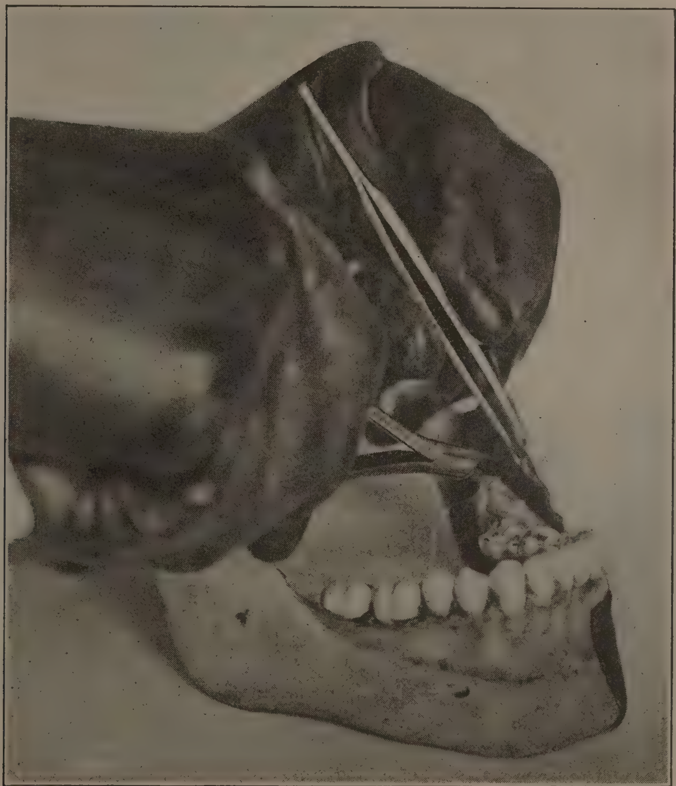


Fig. 329.

These are likewise quickly and easily made affairs. A Kingsley vulcanite scraper with its edges well rounded, brass tubing and a knob—that's all. It is held in the hand like an engraver's tool, thus giving absolute control over it, while considerable force can be used, and at times it does take force to raise the periosteum.

Needle Guide.—Some times when suturing, I would find it almost impossible to manage some loose flap, and would have the greatest difficulty in getting the needle through in the exact spot desired.

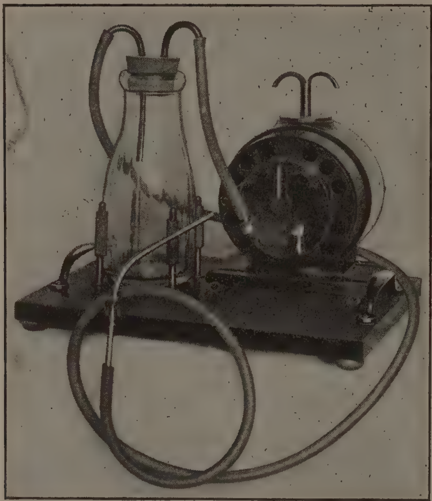


Fig. 330.

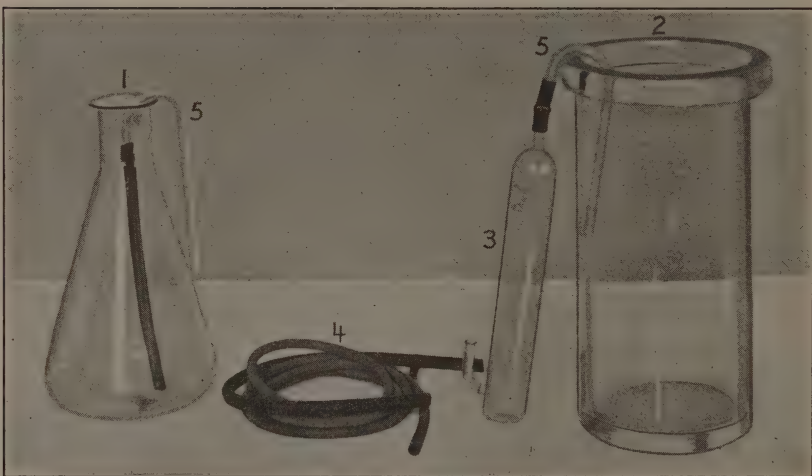


Fig. 331.

To overcome this, I devised a little needle guide, which is a great assistance at times. This is shown in Fig. 328.

With these tweezers, the tissue is picked up in such a manner, that the place for the suture comes at the upper end of the slot. Holding the flap firmly, the needle is run through the guide, flap and all, without

any difficulty. Then the guide can be removed, as the suture passes out through the slot.

This is merely an ordinary pair of tweezers found in a surgical instru-

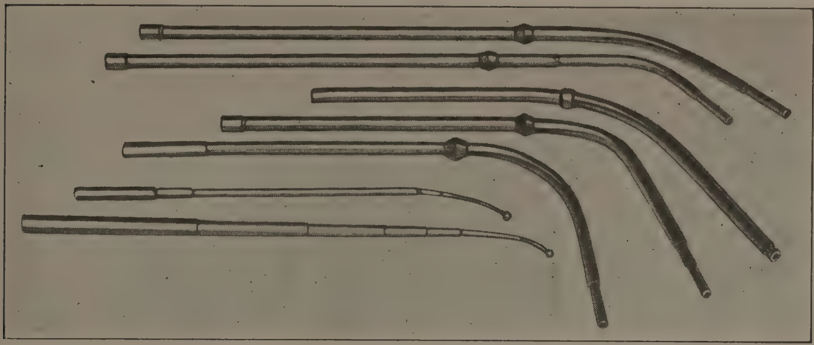


FIG. 332.

ment shop, with a slot sawed in and countersunk at the upper end as a guide for the needle.

In Fig. 329 is shown the needle guide holding up the flap, and the

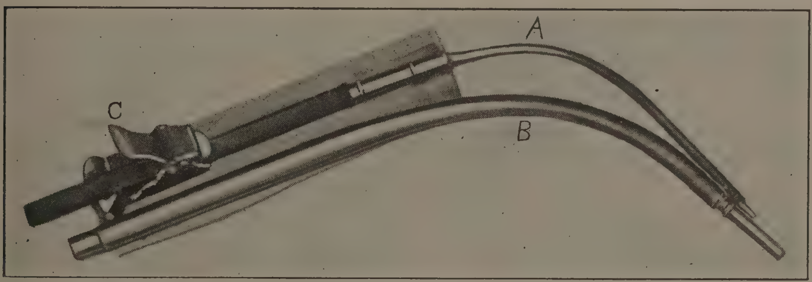


FIG. 333.—A, Small tube supplying iced water. B, Suction tube. C, Snap compression valve.

needle being passed through. This really is a handy little instrument as it facilitates suturing wonderfully.

Suction Machine.—The suction machines, as found upon the market, did not appear to me as being well adapted to the work intended, so an Emerson electric motor was taken in hand, and a vacuum pump built on its shaft. This makes a comparatively noiseless and a very efficient aspirator.

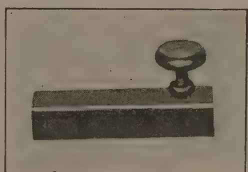


FIG. 334.

A half gallon receiving jar is employed, because quite a good deal of water is used during some operations, and a large jar is preferred upon general principles.

A foot switch (movable) permits the necessary control of the motor, while its stirrup attachment allows of its being moved about by the

foot as may be necessary. Taken as a whole, this is a most convenient and efficient apparatus.

In the illustration (Fig. 330) is shown one of these machines built as a portable, in which a milk bottle is used as its receiver, but when the cooling device is used, a large jar is necessary.

The Cooling Device.—This consists, as shown in Fig. 331, of:

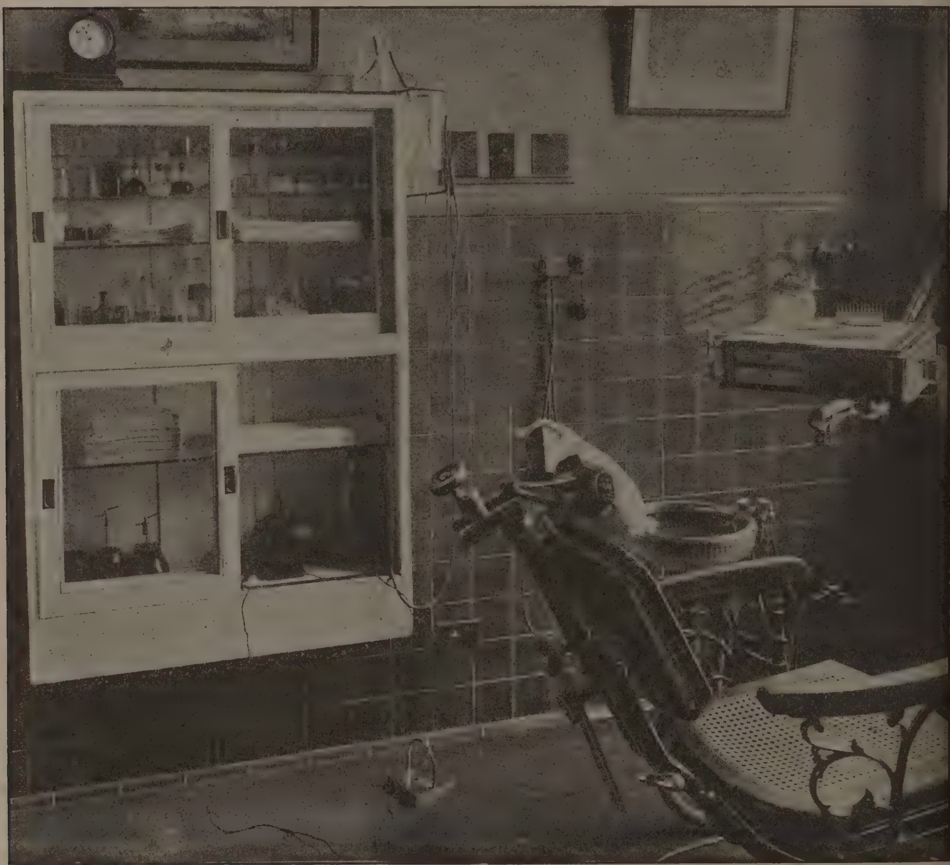


FIG. 335.

1. Flask for holding distilled water.
2. Receptacle for cracked ice and water.
3. Cooling flask through which the distilled water flows.
4. Rubber tubing.
5. Bent glass tubes.

Tips.—Suction and flushing tips are easily and quickly made of telescopic brass tubing and can be made to conform to one's own individual fancy. This tubing can be obtained from any metal supply house, such

as that of Chas. H. Besley & Co., 118 N. Clinton Street, Chicago, Ill. (Fig. 332.)

The Duplex Tip.—This tip is a duplex affair, having two tubes: One, being connected to the distilled water supply, through which flows the iced water; and the other through which the water is aspirated, and which is connected to the receiving jar. (Fig. 333.)

Compression Valve.—In Fig. 334 is shown a small compression valve which is slipped over the cold water supply tubing. By adjusting the little thumb screw, the stream of water may be readily graduated.

The Complete Installation.—The complete apparatus—suction and cooling device—as used in the office, is shown in Fig. 335.

Here the motor and jar are seen to be housed in a cabinet partly sunken into the wall, while the distilled water flask is placed upon the top of the cabinet. In this way, they are all entirely out of the way.

Infection.—When a tooth is entirely embedded in the bone, it does not as a rule, become infected; and, therefore, when such a tooth is removed, the socket usually needs no curetting.

However, if a deeply embedded tooth is in contact with, or impacted against, a tooth which itself is erupted, and such a tooth becomes infected, the infection may spread around the embedded tooth, and then, when that tooth is removed, curetting would be necessary.

Cysts may form around totally embedded teeth, and, under these circumstances, if they are not brought out attached to and with the molars, then they must be removed by means of suitable curettes.

Partly erupted lower third molars are very prone to infection, and give a great deal of trouble from that cause; and when they are removed, the infected soft tissues around them should be cut away and the infected margins of the socket—if any—well scraped.

Curettes.—The curettes of the shapes as shown in the dental catalogs, and almost universally used, are of absolutely no value in my hands. They are bowl or spoon shaped. Infection is not found in such quantities that it should be *dipped* out with bowls or spoons.

When a socket needs curetting, it is because there is a granular mass of infected tissue therein, or a *cyst* exists, and, therefore, an almost flat, sharp instrument would appear to be best adapted to be worked down along the walls of the socket and thus separate the granular mass from the walls, after which this granular mass can be removed whole.

An instrument used in this way requires no great force to be exerted upon it, and, therefore, it does not require a heavy or large handle. On the contrary, the curette, as here described, requires a light handle as it is a delicate instrument and should be handled as is a pen.

In this manner, there is a certain delicacy to the touch by which one

can feel the granuloma or cyst and is guided by this sense of touch during the process of its removal.

Ordinary Kingsley vulcanite scrapers can be quickly transformed into splendid curettes of this character, as they have the shape and edge which exactly suit them to the character of the work which is here considered necessary to best remove such a granuloma or cyst.

In Fig. 336 are shown such curettes, which were quickly made up, and which any one can duplicate. One only has to make up such an instrument and try it for himself to be convinced of its efficiency.

The Place for the Operation.—The witnessing of a number of clinics, upon the extraction of impacted lower third molars, which were conducted in hospitals, only served the more to convince me that a well equipped dental office is the only best place for this operation, and that Novocain is the ideal anesthetic.

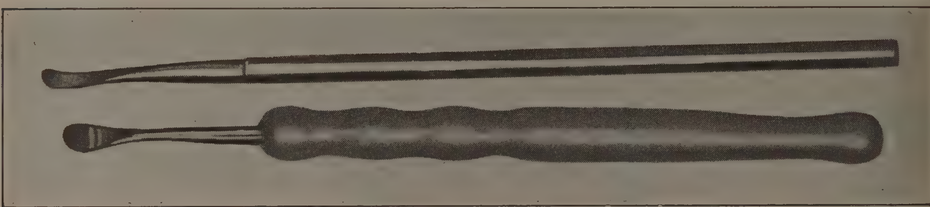


Fig. 336.

Here the patient is placed in a sitting posture, and the best of light is secured. The saliva tube keeps the mouth dry. The dental engine and all other necessary accessories are only to be found in a well appointed dental office.

Here one's well trained assistants are at home, and everything that may be needed is at hand. With all these advantages, why should not this work be performed better, more quickly and with less tax upon both the patient and operator than if done in a hospital?

As a matter of fact, it is believed that, as a rule, the time spent by the operator in merely going to and from the hospital, added to that always wasted by unnecessary waits and delays in a hospital, is more than equal to the time necessary for the entire operation in one's own office.

Preparing the Patient.—A five grain Bromural tablet is usually given before hand to all nervous patients, with instructions to take it about one half hour before the appointment.

Position of the Operator and Patient.—Almost any simple operation may be rendered more difficult by either the patient, or the operator, or both not being placed in comfortable and advantageous positions. Conversely, difficult operations may be rendered less difficult by looking after

the comfort of both patient and operator. Therefore it is that the position of the chair and of the patient is of paramount importance. The chair should be raised and tilted and the head-rest adjusted so that the operator can stand up "good and straight," while the patient is comfortably positioned so as to get the best possible light in the mouth. To lay too much stress upon this point is impossible. As it is not unusual for the operation to be completed without the patient's closing the mouth, the use of a mouth prop (Fig. 325) is frequently advisable.

The Radiogram.—A perfectly satisfactory radiogram is absolutely necessary and must be studied carefully, for upon the shape, and number of roots, of the tooth depends, in a great measure, the choice of procedure as far as details of the operation are concerned. The film is secured in a suitable holder and placed upon the bracket table—always in plain sight during the operation. Fig. 337.

FIG. 337.

Home made film holder. An Eastman clip soldered to a base.

Sometimes, owing to the local conditions, it is simply impossible to place a film in the mouth as far back as the tooth is situated. Then it becomes necessary to take a skull picture, which, while it cannot usually be as satisfactory as the intra-oral film is, is the best that can be done under the circumstances. If the patient can open the mouth slightly, see page 564.

The Novocain Solution.—A minimum amount of suprarenin is used in the Novocain solution, under the impression that the less adrenalin used, the less will be the systemic disturbance. There is no necessity for the reducing of the hemorrhage, because all blood is aspirated by the machine and not a single sponge is ever used during the entire operation. As a matter of fact, it is believed that hemorrhage is preferable to an absolutely bloodless field. The formula used is this:

Novocain	.08
Suprarenin	.00006

One tablet to six mils of Ringer solution gives a one and a half per cent solution, which is used.

The greatest care is given to the preparation of the solution, needles, syringes, etc., and equal care is taken to insure the dryness of the mucous membrane before sterilizing with the tincture of Aconite and Iodin, as it is necessary to insert the needle in a dry field.

Assistants.—In order to "get the most out of it," the method of operating, as now being detailed, really requires the services of two well trained

assistants. The one stands on the left side of the chair, operating the aspirating and refrigerating machine, and assists in many ways. The other stands on the right, looks after the operating instruments, engine and so on, and thus saves the operator much time. However, one can get along with only one assistant, who must then stand on the *left* side of the chair and operate the machines, while the operator must look after his instruments himself.

The Operation Itself.—Coming, now, right down to the operation itself, it must be borne in mind that impacted lower third molars are divided into two classes, and that some of the details of the operation have to be modified slightly according to the position of the tooth, but the general principles hold good for both classes. The slight modifications that are necessary will naturally automatically suggest themselves to the operator at the right moment.

The First Step.—The first step in the operation—that is, uncovering the surgical field—is a most important one. While it must be remembered that the less the tissues are lacerated, the less will be the resultant trauma, still a greater evil is in not obtaining a sufficiently large working field, in which case the soft tissues will be lacerated unnecessarily because they are in the way. Again, one must *see* what one is doing in order to do it well. As a matter of fact, cutting a sufficiently large flap and holding it well out of the way so that it will not be injured during the operation, causes less laceration in the end. The character of the flap is also most important.

Choice of Incisions.—To run the knife (and it should be a sharp one) down the center of the operative field, would naturally result in there being two flaps to handle—one on each side of the cut—and that would be undesirable. To make the incision along the buccal edge of the operative field would only give one flap, it is true, but such a flap is very difficult to take care of. Therefore, the incision is made along the lingual border of the field to be exposed, and thus there is only one flap to take care of, and that is retracted buccally—the most rational way to cut and handle a flap it would appear to me.

Cutting the Flap.—With the knife, Fig. 326 A, and the blade set parallel with the long axis of the handle, separate the gum from the *lingual* and *buccal, distal halves* of the second molar. Change the setting of the knife by giving it a quarter turn, and then separate the gum from the distal margin of the second molar.

To change the position of the blade in the handle, grasp the blade by means of a sterile napkin, give the handle a turn to the left, rotate the blade to the position desired, and then firmly lock it into position by turning the handle to the right—quickly done.

Then insert the point of the blade in the gum at the center of the buccal

wall of the second molar, which is where the other cut terminates, and cut straight down buccally for a quarter of an inch or more, as may be necessary.

The idea of extending the flap along the buccal border of the second

FIG. 338.—This appears to be a model of the right side, but as a matter of fact it is of the left side, and the flap is cut accordingly.

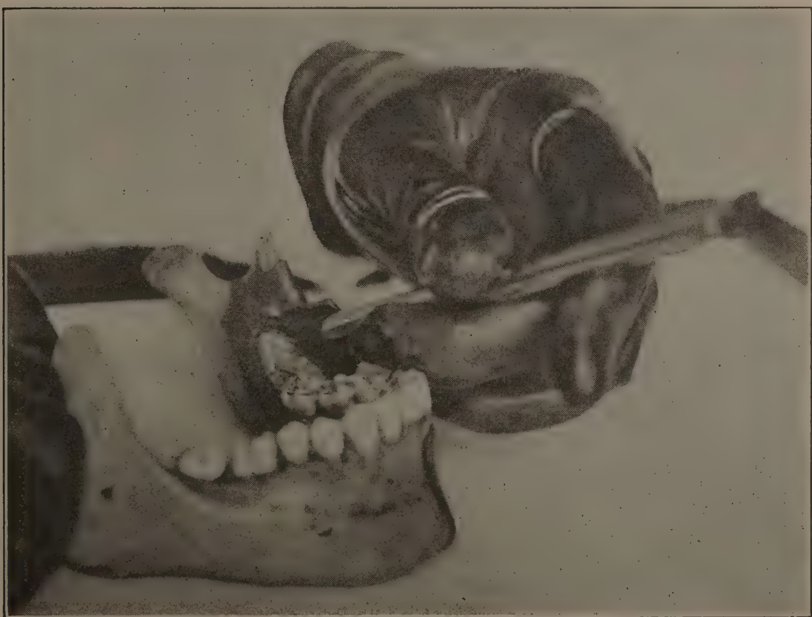


FIG. 339.

molar, as described, was given me by Dr. Charles M. Proctor of Boston. When the flap extends to this point, and is well turned back, it gives a very much better view of the operative field than when the flap terminates at the disto-buccal *angle* of the molar.

Take the knife, Fig. 326 B, and with the blade set in line with the handle, start at the disto-lingual corner of the second molar, sinking the blade down to the bone, and running it backward along the *top* of the *edge* of the bone for the distance rendered necessary by the position of the tooth to be operated upon. Then change the blade by giving it a quarter of a turn, and cut buccally for a quarter inch or more, as may be necessary. These cuts are shown in Fig. 338.

Raising the Flap.—Take a periosteotome, Fig. 327, whichever is best suited to the case, and starting at the cut at the buccal side of the molar, work under the periosteum and backwards, gradually raising and pushing the flap buccally, using every care not to lacerate the periosteum. Push the flap well out of the way, and then, selecting a suitable flap holder, (Fig. 324) plant it firmly against the bone and hold it there with the left hand. Fig. 339.

An ample working field is thus exposed to view, and it is kept constantly

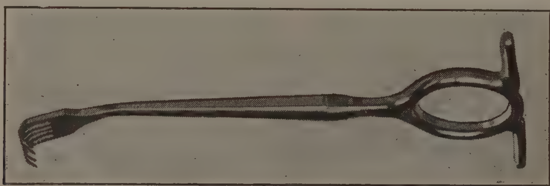


FIG. 340.

dry by means of the aspirating machine, whereupon each tooth becomes a problem unto itself, although the general principles hold good.

A Clear View.—From the moment the knife penetrates the soft tissues, and the flow of blood is started, the assistant keeps the operative field free from blood and in plain view by means of the aspirating machine. Thus being able to see what he is doing all the time and not having to stop to sponge, is a factor of inestimable value, and undoubtedly cuts the operator's time in less than half—an item of the greatest interest considered from whatever angle you will. Besides this, the elimination of all sponging is of the greatest benefit, because sponging does cause trauma. The operator who does not use an aspirating machine, deprives both himself and his patient of one of the greatest aids to a satisfactory operation.

Taking Care of the Flap.—In Fig. 340 is seen the ordinary retractor as found on the market and very universally used.

Any one who uses it, should hook this retractor in his own mouth and pull on the handle and observe the result. Is it any wonder then, that, when a delicate flap is forcibly held away by such an instrument (the prongs of which are sunken into the periosteum, which consequently must be badly lacerated) there is post-operative pain after its use?

Thus it was that these sharp toothed retractors never were used, and that the flap holders already shown in Fig. 324 were originated.

Exposing the Tooth.—When the tooth is entirely or partly covered with bone, the mallet and chisel are used to remove that bone which is superimposed upon the crown, only, of the tooth, and some bone situated buccally to the crown, only, and *not* to the root. Just how much bone

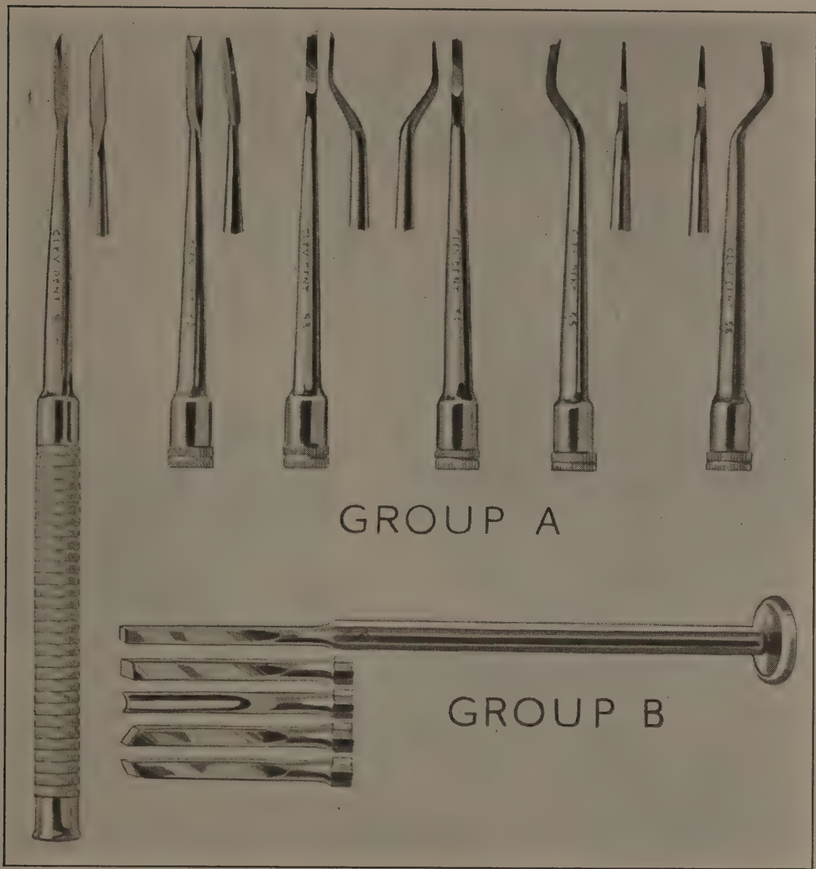


Fig. 341.

should be removed, depends upon each individual case. In Fig. 341 are shown the chisels used. (A) The Boyd Gardner chisels, the beauty of which is self-evident, and (B) The Buckley chisels which were originally intended for root amputation, but which are excellently adapted for all manner of bone work in the mouth. This is a very handy little set.

Sharpening Chisels.—Chisels must be sharp in order to do good work with them. To sharpen them upon an oil stone in the conventional

way, requires a good deal of time and skill. To sharpen them upon a two and a half inch carborundum stone on the laboratory lathe, requires *very little of either*, and the result—to my mind—is just as satisfactory.

Some shapes that cannot be sharpened upon this stone, can be given an edge with a small stone in the engine handpiece.

Cutting the Tooth in Two.—Having thus exposed the crown—or, rather, its distal surface—to view, a three eighths inch knife edge carborundum stone in a straight handpiece is used to cut a nick in the dense enamel, so that an engine drill can take hold. The deeper one can cut this nick, (Fig. 342) without encroaching upon the bony plate upon either side of the molar, the better it is; but one must not cut these bony plates, nor the soft tissues, with this stone. A little judgment is necessary in deciding just where this nick is to be cut, or, in other words, how much of the crown is to be cut off, for there is such a thing as cutting off too little, and it is just as possible to cut off too much. A study of the radiogram at this moment is essential in order to decide where and at what angle it is best to cut each tooth.

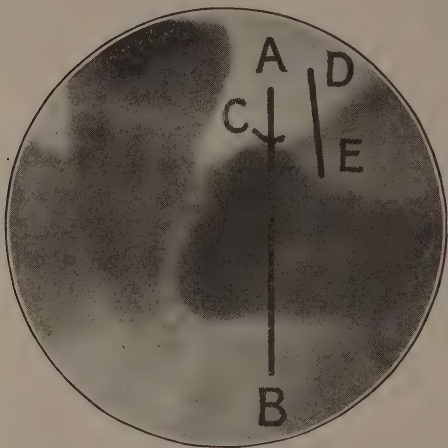


FIG. 342.—The crown should be nicked with carborundum stone at C. The crown should be cut off at AB. The superimposed bone chiseled away to DE.

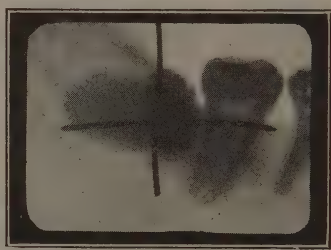


FIG. 343.

A spear drill or round bur is next used in the contra-angle handpiece, with which a hole is drilled right down through the crown of the tooth to a *predetermined depth.* The next step is, to me, the most difficult one in the whole operation, and one upon which the post-operative stage—if there is to be a post-operative stage—very largely depends, and that is the cutting of the tooth in two without injury to the lingual or buccal walls of the socket or to the soft tissues.

It must also be remembered that the inferior dental canal may be very near the deeply placed *mesial* wall of the crown of the tooth, and it would be very disastrous if this canal were entered by the bur or drill. The burs and stones, to be used for the operation, are selected in advance, placed in their racks and sterilized.

Avoiding Trouble.—In order to lessen the chances of cutting through the crown, and then on into the underlying bone, the following method has been devised.

Two pieces of brass or copper wire are cut of the proper length and secured to the film by means of wax, whereupon the radiogram is taken, with the result shown in Fig. 343. With a pair of dividers, the lengths of the wires themselves are compared to those of their shadows upon the films,

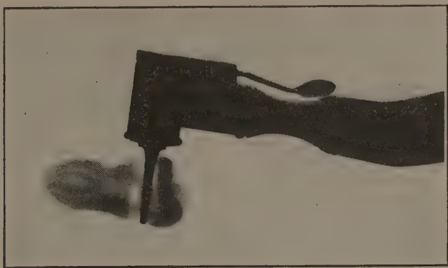


FIG. 344.

and thus a fair idea is gained of the amount of distortion which exists in the shadow of the tooth, and thus due allowance can be made for it.

By thus measuring the vertical wire, the depth of the crown from A to B can be very closely computed. It is now a simple matter to break off the ends of the fissure burs shown in Fig. 322, thus shortening them to such a length that when, during the process of drilling through

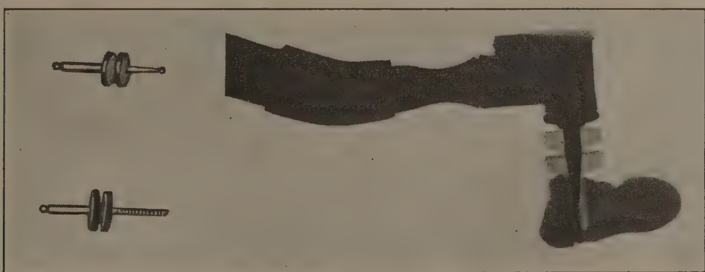


FIG. 345.

the tooth, the handpiece has reached the top of the tooth, the end of the drill will have just gone through the tooth and can go no farther. Thus drilling too deeply is readily prevented. Fig. 344.

Round burs and spear drills, which are also used at times, (and furnished by the manufacturers in unusual lengths for this purpose) cannot, of course, be shortened by breaking them off; so, should they prove to be too long, they are taken care of in another manner.

The hole in a hard buff polisher is enlarged sufficiently so that it will slip over the bur and fit snugly on the shank, and so by means of one or more of these "washers," the working length of these burs and spear drills may be adjusted. In Fig. 345 are shown these burs with the washers on. Special burs can be likewise guarded if desired.

After the spear drill or round bur has been used to start the work, the rest of the cutting is done with special burs, by giving a perpendicular sawing motion to the handpiece.

Naturally, the bur should be sunk to the full measured depth only in the thickest part of the tooth. When it comes to cutting towards the labial and lingual borders, one must be very careful not to drill too deeply. It is possible to tell by the feel of the bur when it has gone through the enamel.

If the lingual plate is encroached upon to any extent, by the bur, trouble is sure to follow. If the bur goes down beyond the tooth to any great extent, the inferior dental nerve may be injured, in which event the anesthesia may last for several months. Unnecessary cutting of the buccal plate is less apt to cause trouble, but, of course, should be avoided.

As just stated, this is a very difficult stage in the operation, and, in order to perform it properly, one must have the operative field in plain view by a thorough retraction of the soft tissues and the use of the suction machine. While cutting in the direction of the lingual wall, if necessary, the thin blade of a flap holder can be pushed down between the alveolar plate and the gum, and held there by the assistant in order to protect the soft tissues.

The Breaking of Instruments.—It is not unusual for one of these fissure burs to break, and when that happens, the broken point must be found and removed. This can often be very readily accomplished with the irrigating device, the stream from which will wash out the broken bur from the deepest nook or cranny, whereupon the aspirating machine may instantly whirl it into the jar. (Fig. 346.)

Renewing Burs.—No bur will cut very long when operating upon these dense crowns, so as soon as one gets dull, it must be discarded, and a new one taken up. From three to six burs are usually used upon a tooth, and occasionally even more than that.

Refrigerating the Parts.—At the moment the cutting of the tooth is begun by the carborundum stone, the assistant floods the stone and the tooth with the iced distilled water by means of the device already described. During the entire time of the cutting of the crown, the cutting instruments and the operative field are first flooded with iced water, and then it is aspirated away. Not only is no heat generated by the cutting instrument, but, on the contrary, the temperature of the tooth and the

surrounding tissues is very materially reduced below normal. A test shows that the water as usually used, is delivered to the tooth at a temperature of 60° F. or thereabouts.

Removing the Severed Cusp.—As soon as the tooth is severed, the anterior portion, being *loose*, is usually removed with little difficulty with any suitable instrument. Frequently an excavator is used for the purpose. The field is then drained by means of the suction machine, and carefully examined. Another careful look is taken at the radiogram before deciding

FIG. 346.—Showing a broken fissure bur against the second molar.

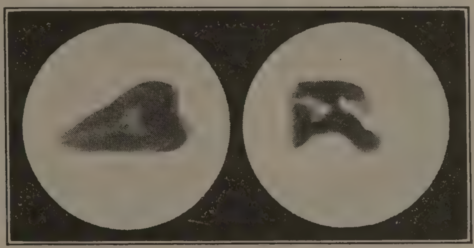


FIG. 347.

exactly how to proceed to remove the root, the paramount idea being to get it out with as little destruction of the surrounding bone as possible.

Removing the Root.—There is no set rule for getting the root out. Wedges, elevators and forceps must each be used either in turn or where best adapted, and I am free to confess that, at times, some of these cases are very refractory. There is never any haste. The work is done deliberately and carefully, with the avoidance of trauma ever in mind.

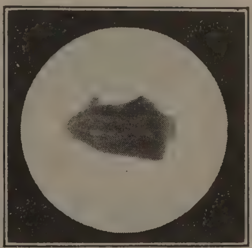


FIG. 348.

If it is a cone shaped single root, as shown on the left in Fig. 347, it can probably be released by the driving of a wedge (Fig. 323) around its margins between it and the socket, and once it moves, its removal is practically accomplished.

If it has a root like the one shown on the right, then there will probably be trouble. When a tooth, however small and insignificant looking it may appear in the radiogram (upon which the knob may not show) has a little knob upon its side and near the end of the root, as shown in Fig. 348, then rest assured it can only be removed with considerable difficulty. The socket of this tooth was one month in healing, during which time it gave considerable trouble.

Under these conditions, a certain amount of bone must be cut away from around the remaining portion of the crown and possibly from

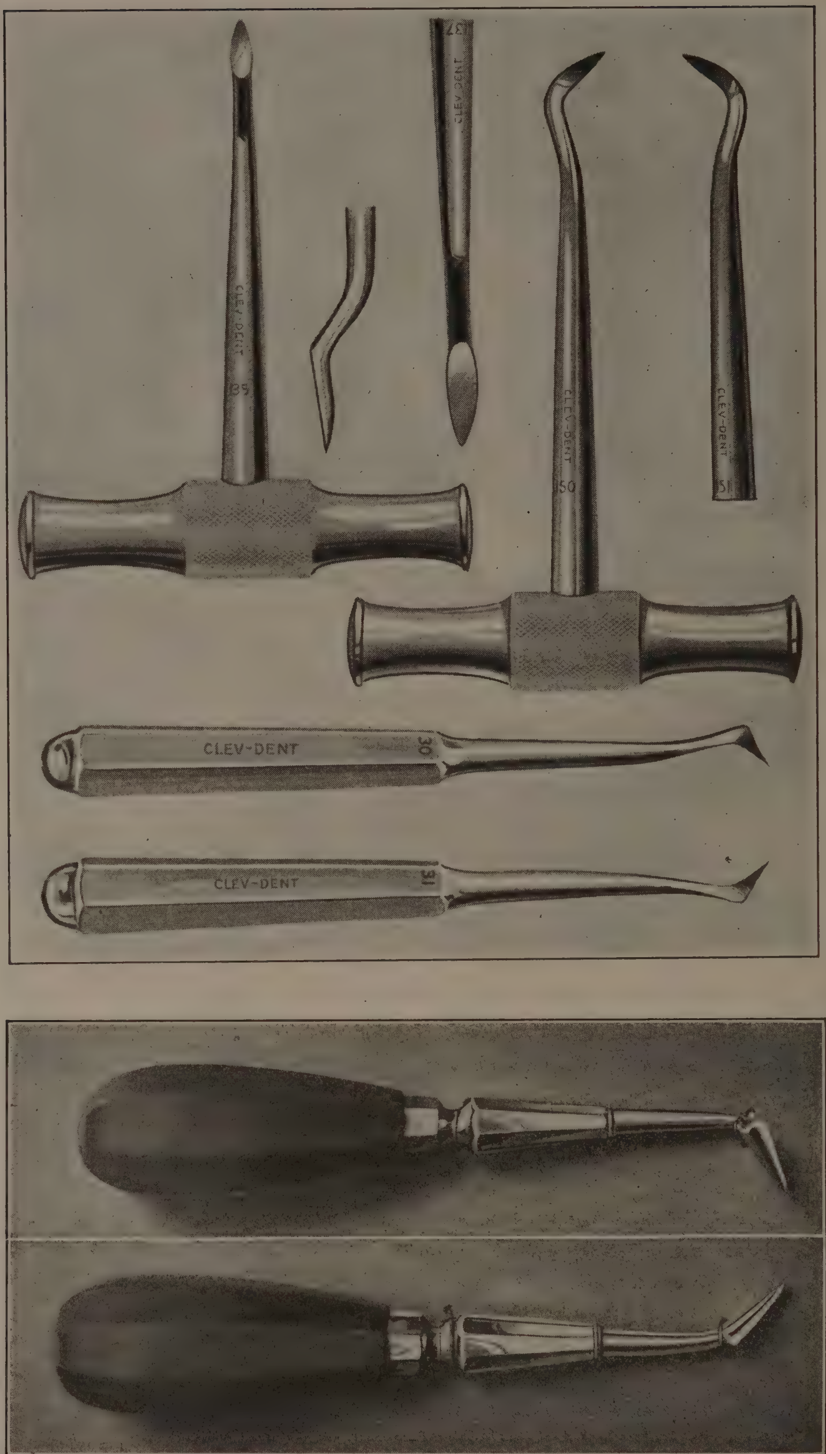

CLEV-DENT
35
CLEV-DENT
37
CLEV-DENT
50
CLEV-DENT
51
CLEV-DENT
30
CLEV-DENT
31

Fig. 349.

around a part of the root itself, which can usually be best done with the engine, although the occasional use of the chisel is sometimes found desirable.

It must be noted that, in order to release the root by means of chisels, a relatively large amount of bone would have to be cut away,—the very nature of the instrument renders anything else impossible—while with the engine drill, the bone immediately surrounding the remaining part of the crown and of the root, where necessary, can be cut away and the socket just merely enlarged, if you will, just where it is needed and to any desired degree. Very frequently, a very little drilling around the buccal and distal portions of the tooth is all that is necessary.

In other words, with the engine, one can cut a little gulley in the bone alongside of the root, as wide and as deep as one will, while with the chisel, one would have to slice off a large portion of the bone.

Upon the completion of this drilling, the tooth is frequently started from its seat by the use of these driven wedges (Fig. 323), or possibly by an elevator, or maybe it can be grasped by the special forceps (Fig. 350); and once it is well started, the rest is usually comparatively easy.

It is undoubtedly very unsafe to use great force upon an elevator, and the cross handled elevators should, therefore, be used with the utmost care. It is known that some excellent operators have been so unfortunate as to break some jaws under such circumstances. If undue force is never used upon an elevator, then it must naturally follow that it would be impossible for such an untoward result to occur.

There are innumerable forms of elevators to be found listed in the catalogs, but the judicious selection of a few, makes a set that contains all the instruments necessary. In Fig. 349 are shown the elevators I now use.

Caution.—Whenever an elevator is placed in position under a lower third molar, or in any other position in the mouth, for that matter, a finger or thumb of the other hand must always be placed over the tooth in order to prevent its falling into the mouth, and possibly being aspirated into the lungs. Always bear this in mind.

In a difficult case, the work proceeds slowly. A little cutting, then the use of an elevator, or possibly forceps, or a wedge is driven. The root does not move. Then a little more cutting, and again the various instruments are tried in succession. Finally the cutting has progressed to the stage that the root is started by one or the other of these instruments it matters not which, so long as it is started—when possibly it may be grasped by the forceps (Fig. 350) and finally brought out, or the root may be completely extruded by an elevator.

Special Forceps.—All forceps, as far as known, are made to fit the roots of teeth as they stand vertically in the jaw. None are made to fit the root

of a tooth lying horizontally and deeply embedded, and yet forceps for such a purpose are frequently required.

Take an Ash #45, and grind the beaks out until they are shaped as shown in Fig. 350. Then these beaks will fit and grasp a horizontal tooth as shown in Fig. 351. These forceps are frequently used in removing the

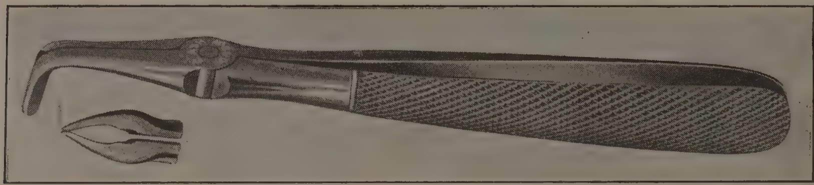


FIG. 350.

root after the cusp has been cut off, besides which they are very useful in many other cases.

Examining the Field.—The removal of the root having finally been accomplished, the soft tissues are next held back by the flap holder, so as to expose the margins of the socket, which are kept constantly in view by means of the suction machine while they are being examined for splintering or roughness, or possibly a loose, or partly loose, septum. Splinters there

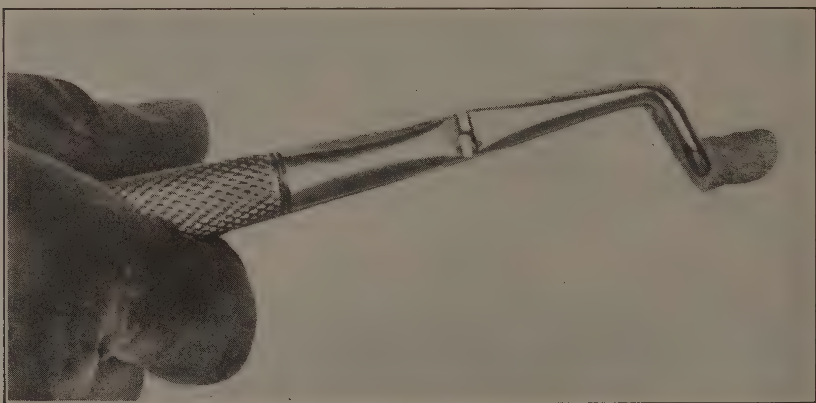


FIG. 351.

should not be, but nevertheless sometimes they are there and, when found, must be removed.

Care of the Margins.—The margins are then rounded off and made as smooth as possible by means of a carborundum stone (Fig. 322) in the contra-angle handpiece, as it is most essential that they be left rounded and smooth, because rough margins or small spicula of bone will surely

cause post-operative pain. This is all done under the intermittent flow of iced water, of course, and is usually a rather difficult procedure because of the inaccessibility of the margins, but they must be made smooth. That the soft tissues must be held well back out of the way with the flap holder, so that they will not be injured by the stone, is most essential.

It is realized that the use of carborundum stones for this purpose will undoubtedly be condemned by most operators, but clinical results (which count most) have proven that they are far superior to burs for this purpose, and so stones are used exclusively.

The results obtained prove conclusively that stones are not objectionable when they are used *under a flow of iced water*. After the use of the stones, the margins are then gone over *wherever possible* with a steel scraper, designed for the purpose, and shown in Fig. 352, or the curette shown in Fig. 336; and this is also done under iced water. In fact the parts are drenched with cold water from start to finish.

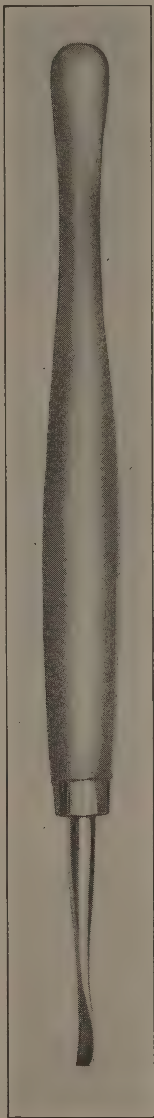


FIG. 352.

Examining the Margins.—After the margins are supposed to be finished, it is most important to replace the flap and then run the index finger over it, and press the gums firmly over the edges of the socket. Sometimes in doing this one will find that the margins, instead of being smooth as was supposed, are so rough that this roughness can be felt through the gum. In that case, the gum is held back again and that roughness smoothed away by means of scraper or stones, or both, and then they are examined once more as before. The importance of this step cannot be unduly emphasized.

The soft tissues are then replaced in their normal positions. If there are any infected edges, or they overlap, they should be trimmed off with scissors. In Fig. 353 are shown the scissors which are used, and also a pair of hemostatic forceps and heavy tweezers, sometimes useful for holding the parts to be cut off.

Cleansing the Socket.—The socket is then washed out with normal salt solution by means of the flushing machine (Fig. 335) and the space under the loose periosteum is well flushed out so that no scrapings nor debris of any kind can remain. In Fig. 332 is shown the ball ended tip used for this purpose.

This ball can be safely placed at the most distant point of the socket, or run under the periosteum without any danger of injuring the walls or the

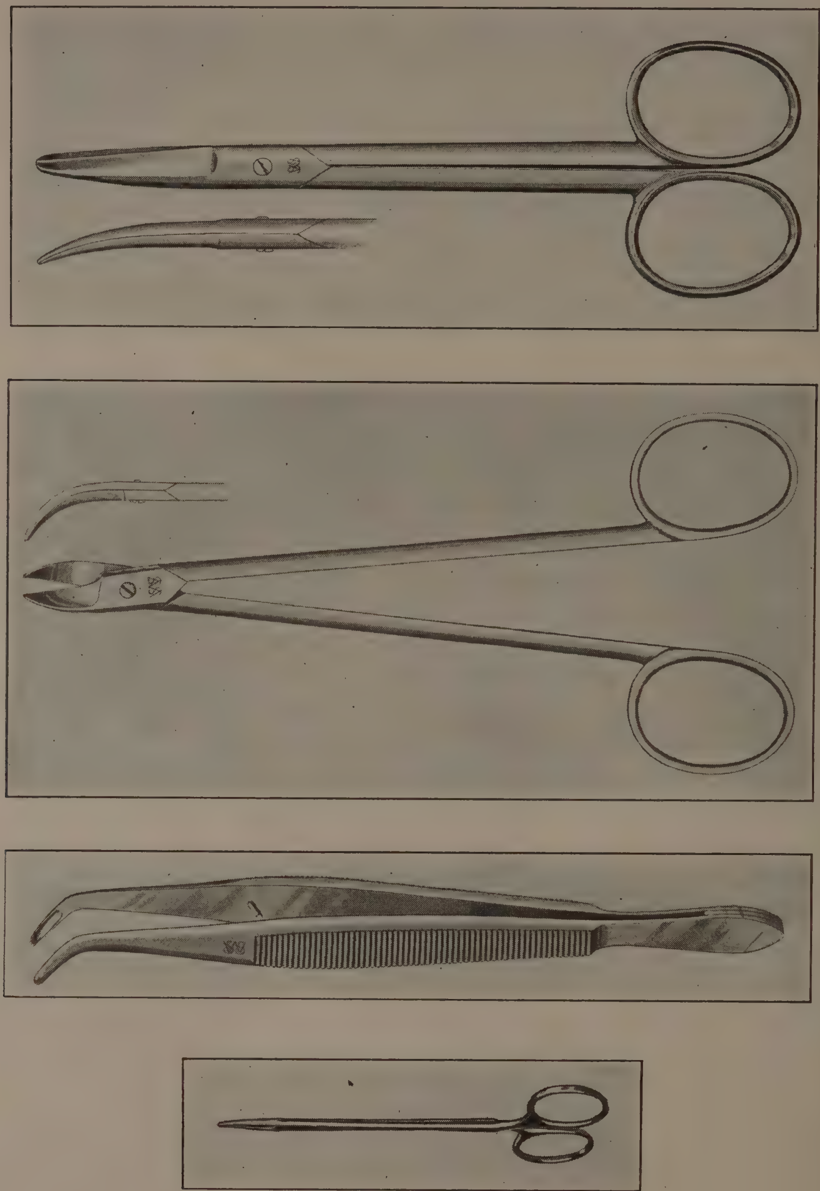


FIG. 353.

tissues, and thus the socket is washed out from the bottom upwards—the only logical method of really clearing it of debris.

If considered necessary—and it is usually safe to do so—a radiogram is now taken in order to see if there are any fragments of enamel or anything else lying therein, which, of course, should be removed. In Fig. 354 is shown a radiogram taken at this stage.

Here is seen a fragment of enamel—a very unusual find. The socket was then well flushed out, whereupon the next picture showed it to be free of all debris.

While this film is being developed, and for fifteen minutes longer, the socket is slowly irrigated with iced water. If no radiogram is taken, the iced water is run through the socket for fifteen or twenty minutes. For this purpose, the duplex tip is removed from the rubber tubing and the ball tip slipped on to the rubber tubing leading to the iced water supply.

Final Treatment of the Socket.—Upon the completion of this cold douche, the contents of the socket are thoroughly aspirated. If the wound is not bleeding, it is made to bleed by means of a sharp knife, and the socket is thus filled completely with nice, fresh blood. If the soft tissues were opened up for a sufficient length to warrant it, one or two stitches are taken; otherwise, not.

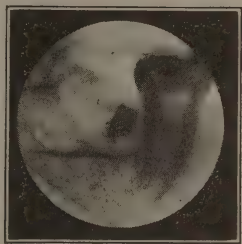


FIG. 354.

Sutures.—Horsehair, dermal and some special "exodontia sutures" have all been tried and found wanting. Some how or other, satisfactory as they seem to be to many operators, they have not proven satisfactory in my hands.

Soft silk—what objection can be raised to that? Only one, and that is that it must be removed. Well, what of that? If the patient lives in the country, surely he can go to some dentist and have the stitches removed. Thus it is that B & B Surgeons' Twisted Silk No. 4, Pyoktanin, prepared by Messrs. Bauer & Black, of Chicago, Ill., is now used for sutures. At times, these stitches are removed upon the third day, while at other times, not until the fourth or fifth. To my mind, this silk has all the advantages of the other materials and none of their disadvantages. This No. 4 silk doubled is usually used.

"*Needle and Thread.*"—A very practical method of keeping needles and sutures in good order and ready for immediate use, is as follows:

Take a piece of aluminum sheet, about twenty-six or twenty-eight gauge B. and S. will answer, and cut it to the size and shape as shown in Fig. 355 A. Smooth the edges with a sandpaper disk, punch a hole in the end with an ordinary plate punch, as shown, and the bobbin is made.

Cut a piece of Pyoktanin No. 4 silk twenty inches long, thread a needle with it, knot the two ends together and your suture is ready. Pass the needle through the hole in the bobbin, and draw the suture through until

the knot stops at the hole. Wind the suture around the narrowed part of the bobbin, and when fully wound up, run the needle under the silk, and you have your needle threaded and ready for use, and in a shape that is most conveniently kept. (Fig. 355 B.)

Prepare any desired number of these sutures and keep them in a clean receptacle. When preparing for an operation which will require sutures, fill a small beaker partly full of 70 per cent alcohol. Place the bobbin therein, ligature ends down, whereupon the alcohol will cover the ligatures, but not the other end of the bobbins. (Fig. 355 C.)

When ready for a suture, remove a bobbin with the fingers, grasp the needle by the needle holder, pull it from under the silk, and let go of the

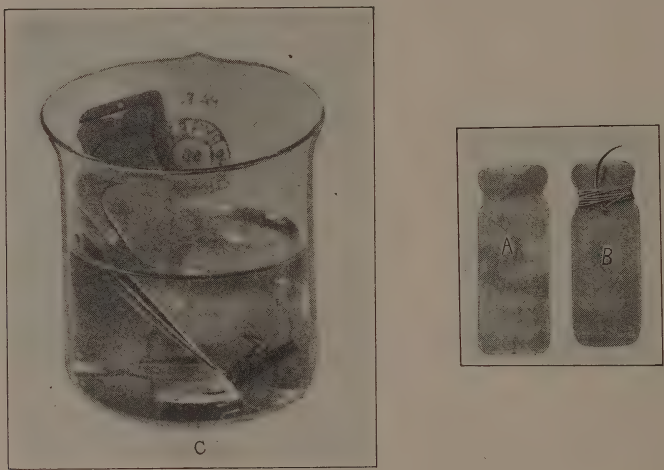


FIG. 355.

bobbin. Grasp the needle in a fold of sterile gauze and change the needle holder to the position desired on the needle. The bobbin now proves a convenient holder for the free end, and the silk is only cut from it after the suture is passed through the gum.

Needles.—The trade name of the needles used is Surgeon's Needles, Full Curved, B—No. 26 (F. A. Koch & Co., New York) and are shown in Fig. 356.

Needle Holder.—Various kinds of needle holders have been tried, and all but one now repose amongst the junk. While holders with locking devices upon the handles certainly appear (to the novice) attractive, such needle holders were never found convenient and, therefore, were discarded.

The simplest of all—the Crile holder, as shown in Fig. 357—is the one now used, and is preferred to all others.

Treatment of the Patient (most important).—As a rule, the moment the operation is completed, the patient is given a cup of coffee. If the patient cannot take coffee, then Aromatic Spirits of Ammonia is given. In Fig. 358 is seen a tray which contains, amongst other things, a can of G. Washington Extract of Coffee, a cup and saucer, spoon and a jar of sugar.

FIG. 356.

With hot water always at hand, a cup of coffee is prepared practically instantly. The patient is now given five grains of Pyramidon and put in the rest room for an hour—no less—with an ice bag on the cheek.

Instructions for the Day.—At the end of the hour, the patient is called from the rest room. If he has not an ice bag at home, or if a stranger in town, then an ice bag is loaned him with the understanding that if he does not feel so well and needs to lie down, he should apply the ice bag while lying down.

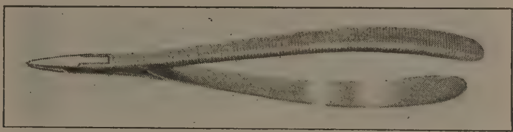


FIG. 357.

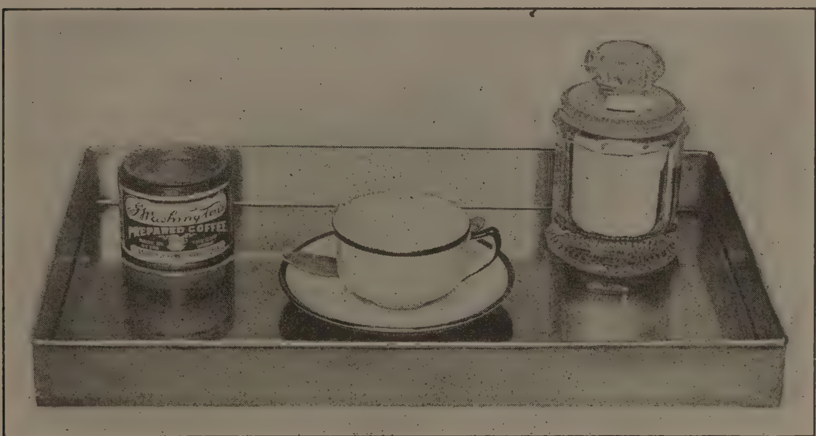


FIG. 358.

The patient is given several five grain tablets of Pyramidon with instructions to take them at intervals of an hour or more, if necessary. He is also told to procure a small bottle of either Tichenor's antiseptic or Pond's

Extract, and use a weak, warm solution as a wash four or five times a day until the socket is healed. Then full mimeographed instructions (page 456) are given and the patient dismissed.

If.—If, and this is a great big IF, all these details have been carried out correctly, then upon the following morning the patient will report that no sedatives were taken after leaving the office; possibly that he or she had been to a picture show in the evening; that a good night's rest had been had, and breakfast had been eaten as usual. Upon examination, one should find that the mouth can be opened as wide as usual and that the operative field looks pink and "fine" and *nothing further whatsoever should be done to the socket.*

If from the country, the patient can leave for home that evening. Frequently, when the operation is performed in the morning, the patient leaves for home in the evening, but, upon general principles, it is preferable for the patient to stay overnight just as a matter of prudence.

When this operation is performed in the ideal manner as described, the patient has absolutely no post-operative pain. It is not meant by this that the patient is not aware that something has been done, but it is meant that the patient can go to his office and continue his work for the day, or play golf if he chooses, or go shopping or to the picture show if *she* so elects.

In ordinary cases, no pain should follow the operation, though sometimes there may be a slight swelling of the face and possibly *slight* trismus—a certain amount of discomfort, and that is all. However, there are times when something does go wrong, and consequently the patient does suffer, and when this does happen, it can usually be traced to *some fault in the operation.*

After Pain.—Should a patient return a few days after the operation, reporting deep burning pain in the socket, the fact can at once be recognized that there is trouble with one of its walls, and the best thing to do is to anesthetize the parts, open up and look for it. If it is a rough margin, smooth it down. If it is a splinter working loose, remove it. The sooner this is done, the better; but it is not always so easy of accomplishment in these inaccessible places.

Contributory Factors.—The satisfactory post-operative period of healing after this operation is largely due to three factors:

1. The elimination of sponging.
2. The elimination of all packing; and
3. The cooling of the operative field.

Infection.—It is not believed that a tooth embedded in and surrounded by healthy bone can, under normal conditions, become infected. This is contrary to the opinion held by many, but it is based upon clinical experience, backed up by what would appear to be good reasoning. If an im-

pacted tooth lays against another tooth which becomes infected, then, of course, the tooth is no longer surrounded by healthy bone, and may, in turn, become infected itself, as has already been stated. Often will a writer or speaker (and men of whom better should be expected) show a radiogram of a deeply embedded and unerupted tooth, and point to the *halo* around it and say, "This is infection." Nothing could be further from the facts.

In the normal process of the eruption of a tooth, the bone around the crown is absorbed in advance and this decalcified area is, of course, radiolucent. Therefore it is that a radiolucent area about the crown of any unerupted tooth is a normal condition. One only has to examine radiograms of children to verify this statement. In Fig. 359 such perfectly normal teeth are shown.

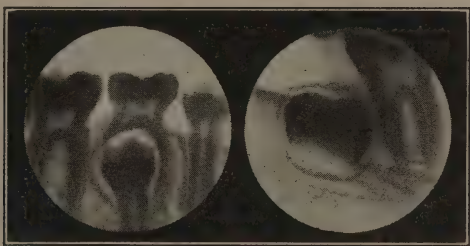


Fig. 359.

The Packing of Sockets.—After using the technique just described, should the patient report the following day, the socket should usually be found to be filled by a firm blood clot, and the process of repair should be well under way.

Assuming that the socket, instead of having been treated as described, had been tightly packed with gauze, (as is quite the custom) what would be its condition the following day? Upon removing the gauze, there would be left a large, empty cavity, and the gauze itself would be found the concentration of infection. What good did the packing accomplish? Being unable to answer this question, it must go unanswered here.

No socket should ever be *packed*. This statement must be qualified, however, in one respect only, because at times a socket may have to be packed to stop a violent hemorrhage, but under no other circumstances should it be packed.

Dressings in Sockets.—Upon the completion of the operation, it is assumed that it has been satisfactorily performed and the blood clot is allowed to form the packing. Should the patient begin to suffer later on, then that is evidence that the operation was not satisfactorily per-

formed, and possibly, under these circumstances, a *light dressing* will be placed in the socket—just a make-shift made necessary by faulty technique.

If, therefore, a dressing is decided upon—as sometimes does happen—the region is protected from moisture by gauze or cotton rolls. The socket is aspirated (never irritated by sponging) until it is good and dry; a few drops of Dentalone are placed in the socket, by means of a small pipette or glass syringe, and then a very *small piece* of gauze saturated with Dentalone is placed therein.

By no means can this be construed as a *packing*. It is not placed anywhere near the bottom of the socket. It is necessary that the *dressing* be allowed to remain twenty-four hours, and then changed or discarded, as may be best. The resorting to such a *dressing* is always a great humiliation, because it demonstrates conclusively that the operation was not properly performed.

Iodin.—The tincture of iodin should never be used in a tooth socket. Iodin is not effective unless applied to a dry surface. It is practically impossible to dry the socket of a freshly extracted tooth, consequently, placing iodin therein is absolutely of no value. If the socket and its walls could be dried and the tincture of iodin applied, then that would kill the new growth of reparatory tissue, and, therefore, the cure would be worse than the disease. The removal of a tooth should be a clean, surgical operation, and, therefore, no sterilizing agent should be placed in the wound.

Pain.—Everybody dreads pain. Pain in the daytime is bad enough, but to suffer at night is infinitely worse. Sometimes after the simplest dental operation the patient suffers, and the suffering is prolonged because the patient knows not what to do. Sometimes secondary hemorrhage occurs when least expected. The former is unpleasant, while the latter is frequently unnecessarily alarming.

After the removal of an impacted tooth, the considerate dentist must advise his patient what to do in case the unexpected happens. Finding that it was practically impossible for almost anyone to remember all that was necessary, I had my instructions typed and mimeographed.

Upon giving a copy to a patient, I say, "If the socket starts to trouble you, or anything unusual happens, begin at the beginning and read on, and when you come to that part that applies to your case, just follow the instructions given." This is a rapid, simple and efficient way of dealing with the subject, which has proven very satisfactory.

Breaking Off a Root End.—In Fig. 360 are to be seen a few selected cases which show that when these teeth were formed, Nature evidently did not expect them to require "pulling." That these crooked root ends were not broken off during their extraction, was simply a matter of good luck and not of skill.

When an entire root is broken off, then such a root must necessarily be more or less accessible, and undoubtedly should be removed, but when a tiny root end, only, is broken off and left deeply embedded in the solid and healthy bone, then I, for one, say that it had best be left there for the time being.

It is admitted that if any one has the dexterity and skill to remove this tiny root fragment without undue injury to the bone surrounding it, then he should remove it, but the average operator could not do this, and rather than play havoc with the bone, I prefer to leave it undisturbed.

Such a root fragment cannot possibly do any harm, but even if it should start something later on, then would it be time enough to endeavor to take it out. Most of these roots slowly but surely work their way towards the surface and finally can be quite readily removed.

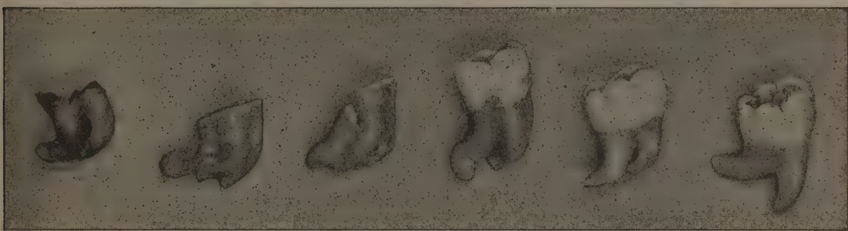


FIG. 360.

Speed.—The operation, as described, is neither rapid nor easy, and while the various steps of this operation call for most accurate and delicate handiwork, they are not beyond the ability of any good and careful operator. The same painstaking attention given to its details, that are essential to the accomplishment of any other difficult operation, is all that is needed.

Ideals.—The ideal results which should follow the removal of impacted teeth, for which all should strive, should be that the operation itself should not have proven to be a strenuous one for the patient, and it should be such a one that it need not have been performed in a hospital. The post-operative results should not be more serious than those to be expected after the extraction of an ordinarily difficult tooth.

For those who achieve these results by the use of mallet and chisel, or in any other manner, it were folly to consider the method here presented; but for those who are not accomplishing such results, the careful consideration of the operation as described is earnestly urged.

Consideration of the Patient.—The consideration of one's patient (1) physically (2) mentally, and (3) financially, should be considered of paramount importance.

1. Every means should be employed to lessen the patient's physical discomfort.

2. The patient's mind should be relieved as much as possible, and never anything said to cause unnecessary fear or distress; and

3. The patient should never be put to unnecessary expense.

If a patient is placed in a hospital for the operation, there will be the usual charge for the necessary room; the fees for the operating room; the anesthetist, if ether is used, and other incidentals as well. If the operation is performed in one's own office, there will be no such expenses, which would naturally appeal to every one, but especially so to patients of moderate circumstances.

Fig. 361.

In Fig. 361 is shown what is probably one of the most remarkable cases of impacted third molars on record. Remarkable in so far as results go. These four very badly impacted third molars are the personal property of a young woman who has been a patient for a great many years.

They were discovered by means of the ray about eighteen years ago, and, up to this writing, have never caused her any trouble. She is perfectly normal in all respects, and has always enjoyed exceptionally good health.

Under these circumstances, she has never decided that it was worth while to have them removed, and in view of the fact that they had never caused her any trouble, there was no occasion to urge her to have them removed. These individual pictures were taken ten or twelve years ago.

Forcible Eruption of Impacted Lower Third Molars.—It is possible to discover, by means of the ray, unerupted and impacted lower third molars, which may be so slightly impacted that their forcible eruption is possible, whereupon they will become good and useful teeth. In Fig. 362 is shown the model and skiagraph of such a case.

FIG. 362.

The Procedure.—The gum over the entire crown should be excised, then with suitable burs in the engine, and under a flow of iced water, as heretofore described, a little of the process—distal to the crown only—of the tooth should be cut away.

Then, during several months, possibly every two or three days, or oftener, if convenient, the tooth should be "worried," first with a wedge of cotton or silk tape, traction cord or orthodontia wire—whichever can be used—and then with wooden wedges driven in, and occasionally using a thin steel bladed instrument applied with force against the tooth.

FIG. 363.

By these several methods, the tooth will be, in the course of time, finally *released*, whereupon it will erupt. In Fig. 363 is shown the finished case one year after the work was begun.

CARE OF THE MOUTH AFTER TOOTH EXTRACTION*

Complicated Extractions.—After severe or complicated operations have been undergone, more especially those in which the tissues were infected at the time of the operation, the patient must expect more or less discomfort or pain, according to the conditions of the case, and should always carefully follow the instructions which have been given for their relief.

TREATMENT AFTER TOOTH EXTRACTION

NEVER use a hot water bag or electric pad directly on the face for any kind of pain caused by a tooth, or tooth extraction.

If an ice bag is placed on the face immediately, or soon after, the difficult extraction of a tooth, it may prevent swelling of the face.

AFTER the face has swollen, moist heat, as a rule, should be applied to the face. Antiphlogistine is the best agent for this purpose. This must be applied directly to the face, covered preferably first with a piece of rubber dam, gutta percha tissue, or even waxed paper if nothing better can be had, over which a piece of linen (an old handkerchief will answer) should be placed, and then a bandage applied to hold it in place. This should be kept in place all night; and, if desired, a hot water bag or electric pad can be used over this.

Hot, weak solutions of Tichenor's Antiseptic or Pond's Extract can be used in the mouth, at frequent intervals, to advantage.

In some severe cases, poultices, made of slippery elm bark, used in the mouth will give relief. (Instructions further on.)

Once in a great while, a patient will report that hot applications appear to aggravate the pain. In such cases, cold applications, of course, should be used.

In addition to these local applications, Pyramidon in five grain doses; repeated at intervals of an hour or two, should be taken. Not more than twenty-five grains of Pyramidon should be taken within twenty-four hours. In very severe cases, where Pyramidon gives no relief, Codeine should be used, but upon prescription only.

Sometimes, during the extraction, the thin margin of a socket is strained or cracked, and a small piece will work out later on, and is usually mistaken by the patient for a piece of root. During this process of exfoliation, considerable pain may result, but it cannot cause any serious trouble.

Again, during the extraction of a tooth, the tiny end of a crooked root may break off, and sometimes, in order to remove this, such extensive cutting of the bone would be necessary, that to allow it to remain might

* These are the instructions furnished the patient.

prove to be the lesser evil. As a rule, such a root fragment will do no harm, and later on it will probably come to, or near, the surface when it can easily be removed with but little difficulty. However, it is always better to remove the root fragment if it can be done without undue injury to the surrounding parts.

Hemorrhage.—Secondary hemorrhage from a tooth socket, while most unpleasant, is not necessarily alarming. It usually can be stopped by making a wad of gauze or a piece of linen cambric, placing this over the socket and biting down upon it, thus stopping the flow of blood by pressure. This pressure should be kept up continuously, without releasing, for a good many minutes—thirty or longer, if possible—by which time a good blood clot should have formed. In obstinate cases, the dentist or physician must use more efficient means.

Allaying Pain.—Heat applied to the seat of pain usually proves to be the best remedy. Within the mouth it can best be applied by means of poultices used as follows:

Make three small bags, out of old linen cambric, about the size of the end of your thumb, and about one and a half inches long. Fill these half full of powdered slippery elm bark and sew them up. Place these in a saucepan of hot water, and keep the water hot while in use. Place one of these hot poultices in the mouth over the seat of pain—usually between the cheek and the socket or tooth—and hold it there until cool. Then place it back in the hot water and put a hot one in the mouth. Keep this up for one hour by the clock, changing the poultices just as fast as they get cool. Repeat this performance two or three times a day, as long as necessary.

Rubbing the face with camphorated vaseline or oil, for ten or fifteen minutes at a time, is soothing and may hasten the reduction of the swelling.

If one would just stop for a moment and consider what it means to forcibly tear out a tooth which is set firmly in the jaw, the wonder is, not that there is some suffering afterwards, but that the consequences are not always really very serious. The fact is that the removal of some teeth is a surgical operation of no mean degree.

CHAPTER XXVIII

THE PLANTING OF TEETH

BY C. EDMUND KELLS, D. D. S.

THE PLANTING OF TEETH

The planting of teeth in the human jaws may be done under various conditions, and the operations may be classified chronologically, as it is believed that they were introduced into the practice of dentistry as follows:

1. Replanting.
2. Transplanting.
3. Implanting.

Replanting—By this term is designated the operation of restoring to its original socket the tooth which has been torn therefrom either accidentally or intentionally. This operation has been more or less in vogue ever since the days of Ambrose Pare (who died in 1590) and to-day is considered good practice, under the following conditions, by some of our ablest operators.

(A) As a last resort to cure a refractory abscess.
(B) When a tooth has been accidentally removed by the forceps.
(C) When a tooth has been accidentally removed by force.
(D) For re-aligning a tooth.

Limitations of the Operation.—It must be conceded that replanting is best adapted to tapering, single rooted teeth, although replanting of lower molars, when their roots are neither divergent nor curved, may be safely undertaken. The crushing of the root, during the process of extraction, in such a manner as to render replanting impossible, is a contingency which must always be reckoned with.

Prognosis.—Sooner or later, the roots of all replanted teeth become absorbed and finally the teeth are lost. (Fig. 364.) However, replanted teeth have been reported to be still in good condition twenty years after replanting. My best result was a lower molar which stood nineteen years. Many have now passed the fifteen year stage, and many more have stood for ten years, and are *still there.*

The Reason for It.—My line of reasoning upon the subject of replanting is about as follows:

Judging from my own viewpoint, the loss of a single anterior tooth, while the rest of the teeth remain intact, is, to-day, nothing less than a calamity, because if there is any good and satisfactory manner of inserting an artificial substitute in its place, I have never heard of it. A plate is objectionable from the patient's standpoint, and to cut into a good and perfect tooth, for the purpose of obtaining an abuttment for a bridge, is scandalous.

Therefore it is that I say to my patient something like this: "As far as I know, there is no *satisfactory* manner in which an artificial tooth can be inserted to take the place of this tooth, the extraction of which is contemplated. If it can be extracted without injuring the root, then it can be put in condition while it is in the hand, and can be replaced. In that case, the probabilities are that it will become firm and last anywhere from five years upwards. It certainly would be expected to last ten years. Now then, there is no telling what improvements may be made in the next few years, and should this tooth fail at the end of ten years, then

Fig. 364.—Showing replanted roots lost through absorption.

possibly by that time some better means for its replacement will be at hand."

How this theory works out is well illustrated by the following case. A man from "up country" came to me for an oral examination because he was suffering from neuritis. An upper lateral with an imperfectly filled root canal, and a decalcified area (possibly a granuloma) at its apex, was found; and he was told that if all other efforts to put the tooth in good condition should fail, the tooth should be replanted as a last resort.

He did not appear pleased, and he went to one of our famous institutions a good long distance away, where this tooth was diagnosed as infected and probably the cause of his trouble, and its extraction was advised. It was extracted, and six months later the patient was still suffering from his neuritis, and he had not been benefited by the extraction of this infected (?) tooth in the least.

Then, not liking his appearance with the lateral missing, he went to one of our very best dentists, who very promptly killed the pulp in the cuspid and bridged in his lateral (a case of modern dentistry).

When that patient presented himself at the gates of this *great institution*, he had one pulpless lateral and a perfectly good adjoining cuspid, and a case of neuritis. As a result of his visit, he had one tooth extracted, one good and healthy pulp killed, one bridge in place, and the neuritis as well. This may be good medical practice, but it is pretty hard on the patient.

Now that's what happened as a result of a visit to this great institution. Let us see what would have happened if he had followed my advice. The tooth would have been replanted. Let us say that it would have lasted for five years only. At the end of that time, with this replanted tooth about ready for extraction, he could have gone to *this very same dentist*, who, *in three years*, had learned how to make a three quarter crown for a cuspid without destroying its pulp, and bridge in a lateral, and thus my line of reasoning would have become fruitful in his case.

Thus it is that the operation of replanting, when the cases are judiciously selected, is practised and advocated.

(A) *To Cure an Abscess.*—Notwithstanding the modern methods of root canal procedure, the amputation of the ends of the roots, curettage, removal of necrosed portions of the alveolar process, etc., there still present, from time to time, cases of alveolar abscesses which cannot be cured by these means, and yet the loss of the teeth would be deplorable.

Usually these conditions are caused either by the root filling or a broken instrument protruding through the end of the root; or, on the other hand, from the failure of the root filling to reach the end of the root canal. Possibly the side of the root has been perforated. Under these circumstances, *when all other methods have failed*, and as a last resort, the operation of replanting is justified, and the result is usually satisfactory.

When to Replant.—As a rule, the tooth is extracted in the morning and replanted the same day, although in one instance, owing to circumstances beyond control, the tooth was not replanted for several days. At the present time—three years later—the tooth is perfectly satisfactory.

Immobilizing the Tooth.—Just as a surgeon considers it necessary to hold in firm apposition the two ends of a broken bone, so it is essential that the replanted tooth be firmly held in its position. While wire or silk ligatures are used by some, it is undoubtedly better to swage, by the usual methods, a splint of pure gold, which, when cemented in place, will hold the tooth firmly in position during the process of repair—usually about five or six weeks.

Sometimes it is possible to make a satisfactory splint by banding the tooth to be replanted and one upon either side. These bands are made preferably of platinum about one eighth of an inch wide, soldered together and cemented on.

DESCRIPTION OF THE OPERATION

Making the Splint.—Take a plaster impression to include the tooth to be replanted and two or three teeth on either side. Place this upon a slab

FIG. 365.

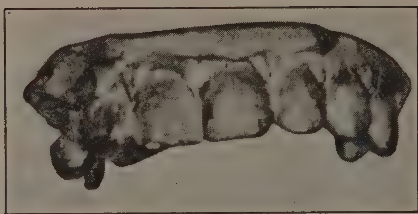


FIG. 366.

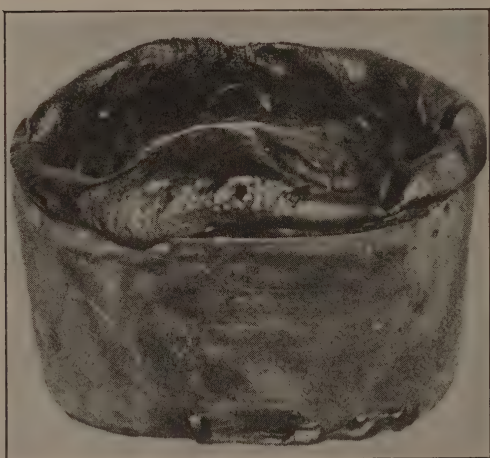


FIG. 367.

and build up all around it with mouldine, thus making a suitable well in which to cast the metal. (Fig. 365.) Cast with fusible metal and the die is made. (Fig. 366.)

Fill a suitable ring with softened modeling compound and press the die therein. Chill and separate and the counter die is ready. (Fig. 367.)

Procure a piece of pure gold plate of suitable size and No. 35 B. & S. gauge. Scarify one side well with a sharp excavator. Place over the die, scarified surface downwards, and mould the gold into place with the fingers, and burnish with suitable burnishers. Remove, trim off certain excess, anneal, replace upon the die, and swage in the counter.

Remove and trim until it is of the size desired, which means that it *does not extend to the gum line anywhere.* Anneal, place upon the teeth in the mouth, and burnish well into place and look after the occlusion. The gold is so thin that it hardly interferes. Remove and fill with tenax and plaster, or the investment of your choice. Flow a small quantity of twenty-two karat solder into each depression, labial and lingual, that is found between the teeth, and flow this solder only near the free border of the splint, and not near the incisal edge. Very little solder is needed. This stiffens the splint. Polish as *may* be necessary and smooth the edges, preferably with disks. Replace upon the teeth and give a final burnish. Remove, rinse well and place in a little beaker or tray containing alcohol. The splint is now ready. (Fig. 368.)

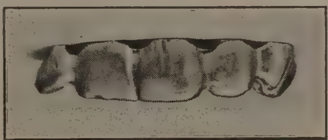


FIG. 368.

Preparation of the Patient.—(1) If a nervous patient, a five grain Bromural tablet is previously given her (?) with instructions to take it one half hour before the appointment.

2. Every effort is made to have as clean an operation as possible. Laboring under no illusion, no hope is entertained that "surgical asepsis" can be maintained.

3. The heads of the patient, operator and assistants are covered with clean—not necessarily sterile—caps.

4. The towel placed over the patient is clean but not necessarily sterile.

Preparing the Paraphernalia.—The extracting forceps, knives, curettes and an abundance of tweezers and mouth mirrors, and whatever other instruments may be needed, should be sterilized by thorough boiling, or in an autoclave, and wrapped in sterile towels; while towels, tape, floss silk, small glass beakers, trays, etc., can be well sterilized in a Rochester combination sterilizer.

The Irrigator.—An irrigator, (Fig. 369) with its rubber tubing and suitable tip, is sterilized by boiling, and charged with warm normal salt solution and kept warm. The bottle is a DeVilbiss No. 57 (two ounce capacity) which throws a fine stream and not a spray. The tip is "home

made" just for this purpose. In order to wash out a socket, the tip should be placed at or near its deepest part, and then the *stream* will wash everything outwards—the only logical method of thoroughly cleansing a socket, it would appear.

Another irrigator, DeVilbiss No. 57 (eight ounce capacity) which

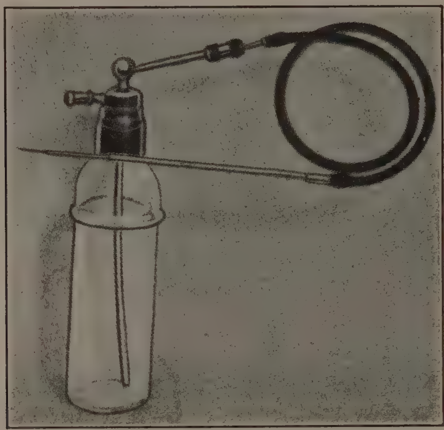


Fig. 369.

also throws a stream, is also used. From five to eight pounds of air pressure is used upon these irrigators.

The Technique of the Operation.—(1) The region is anesthetized by means of novocain-suprarenin.

2. While realizing that it is impossible to sterilize the mouth, it is fully appreciated that to have it as clean as possible is advisable. Therefore, when all is ready, the first step is to thoroughly wash the mouth, teeth and all the interdental spaces with Dakin's solution by means of the DeVilbiss No. 57 (*eight* ounce) irrigator and special tip. Particular attention is given to, and a great deal of fluid is used upon the tooth to be operated upon and the nearby teeth, besides which they have first been polished if necessary.

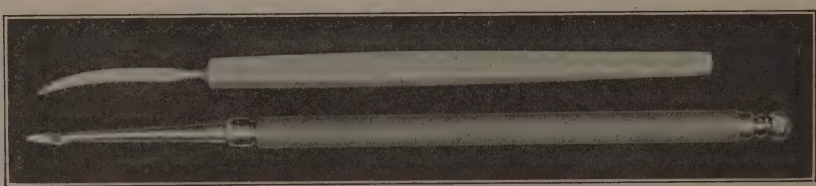


Fig. 370.

3. The tooth to be operated upon is then carefully isolated by means of napkins or cotton rolls.

4. The gum region, buccal and lingual, is thoroughly dried by means of gauze, followed by filtered compressed air, then painted with equal parts of aconite and iodin, and again dried with filtered air.

5. By means of a suitable and exceedingly sharp knife, (Fig. 370) the gum is carefully separated from the tooth, care being taken to injure the gum as little as possible, *or not at all.*

6. The greatest care must be used in selecting the forceps for if the beaks do not fit the root, it may be fractured. None but perfectly smooth beaked instruments should be used.

Special Forceps.—I am particularly fortunate in having a number of forceps specially well adapted to this class of work. Besides the two pairs

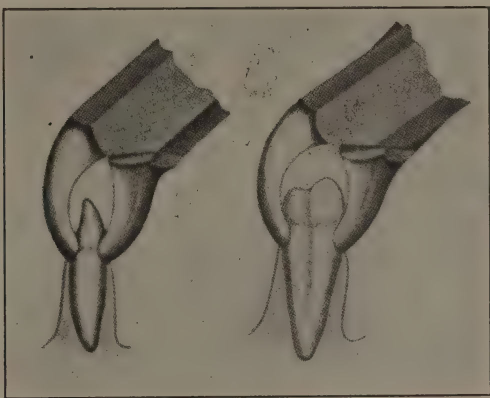


FIG. 371.

of the regularly cataloged Kells Forceps, designed by my father, I have a number of different sizes and angles, which were made to my own pattern, and all with smooth beaks. From this lot, at least, one can undoubtedly be found to fit any normal tooth.

Undoubtedly every operator has his own pet forceps with which he can do this work equally as well, but according to my ideas, the forceps and method of gripping a tooth as illustrated in a catalog of one of our best known instrument makers, and shown in Fig. 371, are both radically wrong. I would expect such a procedure would crush many a root. The forceps used by me are designed for an entirely different technique. The sharp edges of the beaks are gradually worked up under the gum (without injury to it) and along the root of the tooth, and pushed, up or down as the case may be, as far as possible. In Fig. 372 are shown these forceps, some with typical teeth in their grasps. With such well fitting

beaks, the danger of crushing weak roots is reduced to a minimum, and all such teeth, that have been extracted for the purpose of replanting, have thus far been removed without injury.

7. The tooth is now very carefully extracted, and immediately placed upon a sterile napkin upon a sterile tray, and covered with another sterile napkin.

8. Immediately upon the extraction of the tooth, the socket is carefully curetted, washed out with warm saline solution with the irrigator. The end of the small tip is placed at the very bottom of the socket, and by means of this gentle stream, it can be very thoroughly cleansed, everything being washed from the bottom outwards and without producing any irri-

FIG. 372.—Showing three typical bicuspids within the beaks of forceps.

tation, which result cannot be as satisfactorily accomplished in any other way. Swabbing it out with gauze must necessarily produce a certain amount of trauma, and, therefore, *should never be done*, and no antiseptic should ever be placed in it. The socket is then *lightly* packed with one, only, piece of sterile gauze. The napkins are now removed from the mouth and the patient is dismissed for the time being.

9. In order to guard against accidental contamination of the root, during the process of filling, it is now wrapped in ordinary linen tape about three eighths of an inch wide, which of course, has been previously sterilized, and the tape is tied with ribbon dental floss. While doing this, the tooth is handled by sterile napkins or sterile tweezers, and in Fig. 373 is shown the tooth so wrapped and ready for the root canal filling, as the

root end is exposed and can be worked upon, while the crown is also uncovered, as the pulp chamber must be accessible.

10. The tooth, with its root thus protected, can be handled by the fingers, because it matters not if the crown is touched; in fact, it is practically impossible to open up the pulp chamber and fill the canal without handling the crown by the fingers. Of course one could wear a rubber glove, but that is not necessary.

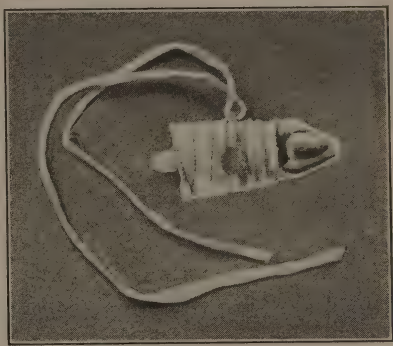


FIG. 373.

The hands are now again well scrubbed with a germicidal soap. Whatever is necessary to place the root canal in proper condition is now done. If necessary, one or more radiograms are taken during the operation. (Fig. 374.) In the end, the root canal has been cleansed, sterilized and filled with *zinc oxy-chlorid* (agate cement)—nothing else—probably gutta-percha points or Iridio-platinum wires being used to carry it to place. The end of the root is now cut off if necessary, which seldom is the case. As a rule, it merely needs polishing, which is done with sterile sandpaper and cuttlefish disks. (Disks are sterilized by means of formaldehyde gas.)

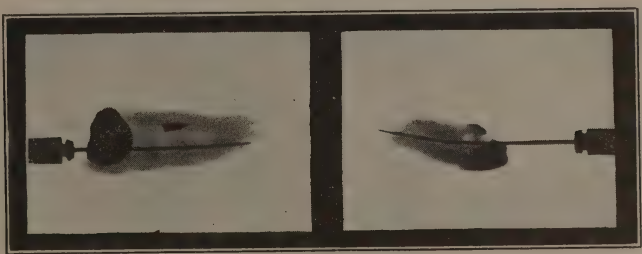


FIG. 374.

If the apical foramen is small enough, it is drilled out and threaded for an S. S. White retaining screw with the instruments furnished for the purpose, and one of these gold or platinum screws is set in, it being first covered with a thin mix of *zinc oxy-phosphate.* If too large for such a screw, the canal is reamed out a little and filled with gutta-percha; the end of the root and filling are made perfectly smooth by means of sterile cuttlefish disks.

The pulp chamber is then filled with agate cement, and finished off with whatever material is indicated, whereupon the tooth is ready for

replanting. During this part of the work, the tooth is securely held by an assistant, giving the operator the use of both hands thus expediting the work very materially.

The patient is now returned to the chair, and, if necessary, the region is again anesthetized as before.

11. The crown, only, of the tooth to be replanted is very carefully cleansed with alcohol. The tape is now removed from the tooth and the tooth is placed in normal salt solution about body temperature.

12. The mouth is again well flushed with Dakin's solution; the socket is isolated by napkins, or cotton rolls, and the surrounding tissues are napkin dried, filtered-air dried, painted with aconite and iodin and filtered-air dried again. Care is taken that none of the aconite and iodin gets into the socket or upon its gauze packing. Upon removing the gauze packing, it is necessary to wash out the blood clot and cleanse the socket, which is again accomplished with warm saline—nothing else—in the irrigator, and a little fresh bleeding, which is desirable, is thus started. Should the socket not bleed, then blood must be started by scraping the walls with a sharp lance. Before replacing the tooth, the socket must be full of nice, fresh blood.

13. The tooth is now grasped by sterile tweezers, laid on sterile gauze, picked up by means of the gauze, and gently forced to place and held there securely for two or three minutes by the clock.

14. The splint is taken out of the alcohol, folded in a piece of gauze and dried by means of compressed air. In this manner, it can be handled and thoroughly dried without any danger of its being squeezed out of shape.

15. The little blood that usually oozes out at the margins of the gum is wiped away. All of the tooth crowns that are to be covered by the splint, are swabbed with alcohol and air dried. A creamy mix of oxy-phosphate is made, and with a small camel's hair pencil, the tooth crowns are painted with it, during which time the assistant fills the splint with the cement, and it is then carried to place; and while thus firmly held, the burnisher is run over the surfaces, free margins and interdental spaces, and it is then held in place until the cement sets.

16. As soon as this cement is hard, the excess is removed, the occlusion is looked after and then the patient is discharged.

Post-operative Treatment.—There should be no post-operative treatment required. Little or no after pain usually results from this operation, and in a few days the sinus, if there was one, is found closed and the parts are apparently back to normal. During the first week, the patient is seen nearly every day, if convenient, and the interdental spaces and the necks of the teeth are thoroughly cleansed with the irrigator and the patient urged to rinse the mouth frequently with the usual mouth wash or even plain water.

The patient should be kept under constant surveyance, and should the splint loosen, it should be re-cemented at once. At the end of the sixth week, the splint should be carefully removed, and if the tooth is not found to be perfectly solid, it should be replaced and worn, say, two weeks longer, when it should again be removed for inspection. It must be worn until perfect union has been obtained.

Should the patient live out of town, he is dismissed a day or two after the operation, with the idea that his home dentist can give the case the necessary care. Sometimes the patient returns at the end of five or six weeks in order to have the splint removed. At other times the home dentist removes it.

In one very hopeless case, the splint was worn even longer without the tooth becoming sufficiently firm, so the splint was removed, the replanted

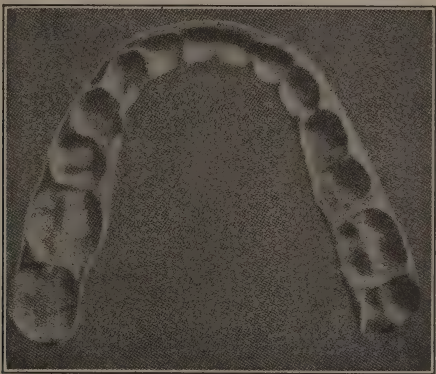


FIG. 375.

tooth and a neighboring one were each banded, the bands soldered together and cemented on. This appliance was neither uncomfortable, unsanitary nor unsightly, and was worn for several months, at the end of which time the refractory tooth finally did become firm and so it remains to-day —thirteen years later.

However, sometimes the unexpected does happen, and then the patient is given the same treatment that follows the extraction of a refractory tooth. The ice pack at once, and so on. See page 449.

Unusual Precautions.—It is usually found that the thickness of the splint or rather let us say its thinness, does not materially interfere with the occlusion, but in some instances a glove-fitting rubber splint has been made to cover the occlusal surfaces and part of the crowns of all the teeth in the opposite jaw, and so made as to relieve the replanted tooth of any possible strain. This to be worn at meals and possibly at night when gritting of the teeth might occur. (Fig. 375.)

(B) *Accidental Extraction.*—A tooth may be accidentally extracted either by the slipping of the forceps, or by the operator placing them upon the wrong tooth. Again, the crown of a lower first molar may decay and break down, whereupon the second molar may tip forward and its crown lean over these roots of the first molar. Should the roots of this first molar be divergent and an attempt made to extract them by means of forceps, the second bicuspid, single rooted tooth that it is, may be raised out of the socket by the root of the molar.

I can speak feelingly upon this point, for it happened to me once in the long ago. It taught me a lesson, however, for, ever afterwards, I would separate such roots by means of the engine and a bur and remove each root separately.

In such cases of accidental extraction, if replanting is decided upon, then the treatment already described should be followed.

(C) *Accidental Removal by Force.*—In almost any case, where one or several of the anterior teeth have been knocked out, it would be no less than criminal neglect for the operator not to attempt their replacement, provided, of course, the teeth or parts were not injured beyond repair.

Treatment of the Socket.—Immediately upon the presentation of the patient, the mouth must naturally receive the treatment indicated by its condition. If the patient is seen immediately after the accident, the proper steps should be taken to prevent swelling and pain. The same general treatment that is used after the removal of an impacted tooth should be employed here (see page 349).

The socket should be left absolutely alone, provided it is filled with a good blood clot. If it is not so filled, then its walls should be gently scraped with the point of a sharp curved knife until it does bleed and become filled with blood. Never swab out a socket with iodin or anything else. Give nature a chance. If, for any reason, the socket should be washed out, then nothing but normal salt solution or freshly distilled water should be used.

Treatment of the Tooth.—The operator's hands should be thoroughly scrubbed with hot water and a good antiseptic soap. Take a camel's hair pencil and cut the ends of the bristles off, leaving a square end. (Fig. 376.) This leaves the brush fairly stiff. Boil this brush for ten minutes. Scrub the tooth with warm, sterile water, preferably distilled, and green soap, by means of this brush, and rinse well with the brush, in several changes of the warm distilled water.

Then examine the tooth well. If the crown is so broken or badly fractured that an artificial crown is necessary, then put on a temporary crown. If found carious, fill it. Pulp chamber and root canals should be filled as just described. When finished, place in a normal salt solution.

The best time to replant the tooth is at the earliest moment possible, taking into consideration the condition of the mouth. However, teeth have been replanted successfully several days after their accidental removal.

Replacing the Tooth.—The technique, as already described, of replacing the tooth, and likewise its subsequent care, should be followed.

Accidental Dislocation.—While not exactly germain to the subject of replanting, it is assumed that the treatment of accidental dislocation can well be considered here.

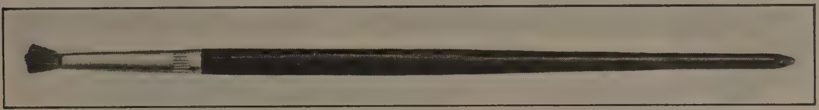


FIG. 376.

Upon the presentation of a patient whose teeth, one or more, had been "knocked out of place," the first question to decide is as to whether or not they should be removed and replanted, or re-set.

Having decided upon the latter course, the teeth and superimposed alveolar process should be very gradually, by gentle pressure, returned to their original positions, and then held there by silk ligatures, if necessary,

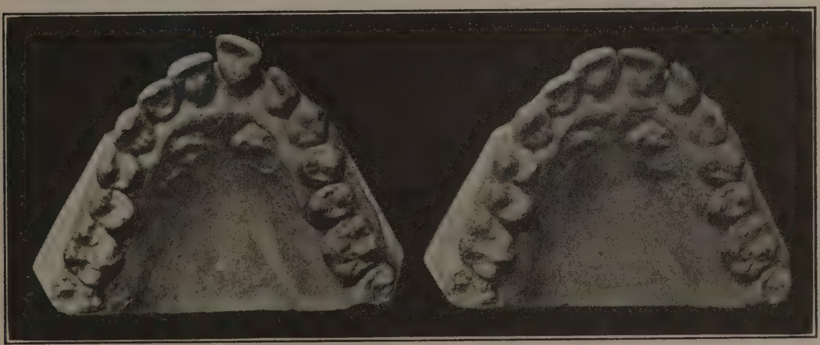


FIG. 377.

while a gold splint is being made for them; and when that is made, it is set in the manner already described.

Subsequent treatment must be given according to the existing conditions of the mouth, all of which has already been described.

(D) *Replanting for Re-alignment.*—Replanting for the cure of pyorrhea is usually impracticable because the operation is not warranted when the disease is in its incipiency, at which time the operation might be successful in eradicating the disease; and later on, when the operation would be

tolerated, the excessive absorption of the walls of the socket would render it impossible.

However, when one or more anterior teeth have been so greatly extruded that the patient is apparently hopelessly disfigured, then it becomes a choice of extracting the teeth and replacing artificial substitutes, or replanting and re-aligning, and as there is everything to be gained and nothing to be lost by attempting this operation, why should it not be done?

In Fig. 377 are seen models of "before and after" of a case which was most interesting. This young girl, about twenty, came in, saying that she was to be married very *shortly;* that her front tooth disfigured her, and that I must do something for her, and this "*something*" was done.

The tooth was extracted; the socket cut out so that the tooth could be replaced in its original position, and the tooth was then replanted. The result of the operation transformed her appearance, and upon her wedding day she was happy with the idea that she had her own tooth—no bridge or plate.

She went with her husband to an Eastern city to live, and after a lapse of nine years some dentist extracted this tooth.

Question. Was or was not that individual operation worth while?

Under these conditions, and in some cases, it *may* be necessary to modify several details of the simple operation so as to meet the changed conditions. These modifications are as follows:

Making the Splint.—Two impressions of the mouth, instead of one, are now taken, and two models made; the one to be retained to show the conditions as they presented, the other to be used for making the splint. The tooth to be replanted is carefully cut out of this plaster model and set with very thin plaster in the position that is to be desired. From this, the usual fusible metal die and modeling compound counter are made. Then the *counter-die* is *slightly deepened and enlarged*, by cutting, all about the *tooth to be replanted.* This is accomplished by means of a small curette or any other suitable instrument.

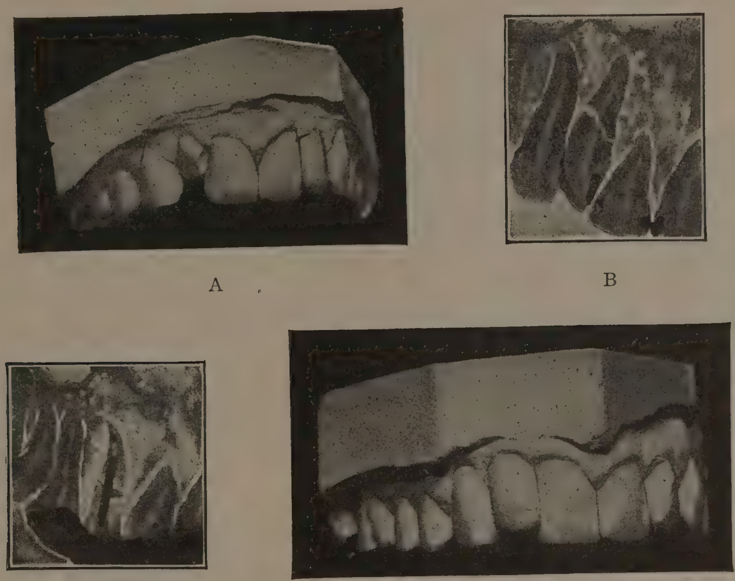
The splint is struck up of No. 35 B. & S. gauge pure gold, as usual, and when finished is burnished into the enlarged impression in the counter where the metal die has naturally failed to carry it. When finished, the splint should fit all of the teeth snugly except the crown of the replanted tooth. The splint is then placed in a small jar of alcohol and all of the succeeding stages are carried out as already described until we reach No. 7.

Changing the Socket.—After the socket has been curetted, it is very carefully cut away in such a manner so as to allow the tooth to be replanted in the position desired. This cutting is done with an Ottolengui implantation reamer, which is admirably adapted to this purpose.

After the socket is trimmed, the tooth, being held in a napkin and never

touched with the fingers, is tried in, and if it does not go to place, the socket is altered a little and the tooth tried in again. This is repeated until the tooth can be placed in the desired position. It is advisable to proceed with this cutting very slowly, as unnecessary cutting away of the alveolus is to be avoided. When the socket is of the proper shape, the operation continues as before described, until the time comes for setting the splint.

Setting the Splint.—The mouth having been prepared as per step number two, the tooth is finally set in place, the splint put in place and carefully burnished to all the teeth and well into the interdental spaces,



A B C D

FIG. 378.

except about the replanted tooth. It is then removed and rinsed, and a small quantity of twenty-two karat solder flowed into all the interdental spaces, as before described, and when completed, it is polished and dropped into alcohol and dried.

A very small quantity of temporary stopping is then warmed and spread over the depression which takes in the replanted tooth (this depression was slightly enlarged it must be remembered).

The tooth is held in the exact position desired by means of any suitable sterile instrument held against its neck, which the splint does not reach. The tip of the tooth is moistened to prevent the adhesion of the temporary stopping; the splint is warmed slightly and forced to place. The temporary stopping moulds itself about the replanted tooth and produces just

enough pressure to force it into its position into the socket. Allowing a moment or two for the gutta-percha to harden, the splint is removed, dried and then set permanently with cement.

While brushing her teeth, a young woman fainted and fell; the brush drove the right upper lateral up into the jaw, and the two central incisors were badly dislocated. Fig. 378. At A is shown the case as it presented.

A radiogram showed that the root of the lateral was fractured—B. This tooth and root end were carefully removed and put together with an iridio platinum dowel cemented in. The lateral was then put in proper condition and replanted, and the centrals carefully restored to their original positions. The lateral soon became firm and all went apparently well, but in a few years, absorption of its root began and it was finally lost. The centrals, however, became firm and are there at this writing.

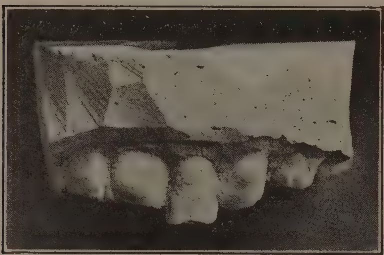


Fig. 379.

C represents the tooth as replanted with the splint on, and D the finished case several months later.

In Fig. 379 is seen a model in which the lateral is greatly elongated. Pyorrhea was the cause, and the tooth was very loose and hopeless as far as treatment was concerned.

It was extracted, the socket deepened with an Ottolengui reamer sufficiently so as to allow of the replanting of the tooth in perfect alignment.

It is interesting to note that the two centrals presented four years ago with what proved to be incurable abscesses, whereupon they were replanted and are in perfectly satisfactory condition to-day.

Special Treatment of Molars.—It is not unusal for a patient to present with a lower molar, one root of which is in a hopeless condition, while the other root is in a comparatively good condition. In such cases, it may be possible to divide the crown, or what is left of it, extract the hopeless root, and put the other root in good condition while it is in place. At other times, even the *other root* cannot be restored to a good condition while it is in the jaw.

In such cases, the tooth should be extracted and then divided. The good root is then treated, filled and replanted as already described. In Fig. 380 are shown cases of this character which have been successfully treated in this manner.

Splinting a Root.—To splint a root, as clearly shown in Fig. 381, proceed as follows:

1. Fit a coping to the root in the usual manner, allowing the post

(No. 16 or 18 B. and S. round wire) to extend through the coping for about an eighth of an inch. Attach this coping to the root with gutta percha. Care must be taken to have the post as nearly vertical as possible.

FIG. 380.—Left upper film. Distal root extracted; mesial root replanted. At the end of a year, all radiolucent areas apparently well filled in, as shown in right upper film.
Left lower film. Large piece of gutta percha extruded through the mesial root canal. Both roots extracted; distal root replanted. Root canals of first molar refilled. One year later entire radiolucent area filled in, as shown by film on the right. Bridge in place.

2. Replant the root. Place over the post a small platinum tube which fits snugly, and yet not so snugly as to prevent its ready removal. This tube should be one quarter of an inch longer than the post.

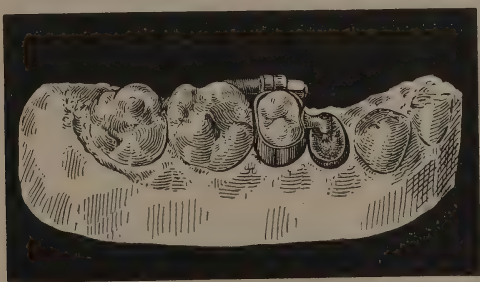


FIG. 381.

3. Adjust a regulating band as shown, or make up one without the screw to fit the tooth.

4. Place the parts in position in the mouth. Take a plaster impression.

5. Assemble the band and tube in the impression and pour a model, using your favorite investment.

6. Separate. Cut out the investment between the tube and band, and place therein a piece of gold wire which will touch both. Fill the tube with something which will prevent the solder from flowing in.

7. Solder, cut off the protruding end of the tube, polish and the splint is ready.

8. Replant the root (with the coping attached) in the usual manner, set the splint in position, and the deed is done.

This makes a very satisfactory splint and one which does not interfere with the occlusion.

This splint should remain on for about six weeks, when it should be removed. If the root is not found to be perfectly firm, the splint should be replaced for another period. I had one very stubborn case, in which the splint was repeatedly taken off and replaced because the tooth would not be found firm. It was most discouraging, as this went on for several months. However, persistence won out, as it frequently does; the root finally became firm, and this tooth is doing good service yet—twelve years after it was replanted.

When the root is found to be firm, then the coping should be heated by means of a hot instrument, (large ball burnisher, for example) and when the gutta percha is sufficiently softened, the coping can be readily removed.

It is now a simple matter to fit a crown to the coping, and, when finished, to cement it in place as usual.

Retention of the Replanted Tooth.—There is no bony union between a normal tooth root and its socket, because the peridental membrane intervenes. As a rule, when a tooth is replanted, this peridental membrane disappears, and a true anchylosis forms between the root and the socket, and it is through this union that the tooth is retained.

Fig. 381B.

Looking at the film of a normal tooth, a fine black line is seen to surround the root. The root of the tooth and the alveolus, which surround it, are both quite dense and not so readily penetrated by the rays, and, therefore, they cast their respective shadows on the film. The peridental membrane, however, is radiolucent—the rays penetrating it readily, act freely upon the film, and so cause a dark line corresponding to its outline.

Now examine the radiogram of a replanted tooth, and the black line is not to be seen, because the peridental membrane has been absorbed. Fig. 381B illustrates this most admirably.

Here the replanted tooth shows no white line (it is a black line on the film and a white line on the print) while the teeth upon either side of it are well outlined by the peridental membrane. This film was taken many years after the tooth was replanted, and the skiagraph shows the absorption of the root is progressing. The gold screw, with which the end of the root was sealed, is well shown.

In Fig. 382 is shown a molar which proved an exception to this rule. This molar stood for nineteen years, and about its roots are seen the typical white lines denoting positively that the peridental membrane was revivified, and that the tooth was held in place by normal gomphosis and not anchylosis.

Could it have been due to the revivification of the peridental membrane that the tooth stood so long? Why not? This picture was taken not

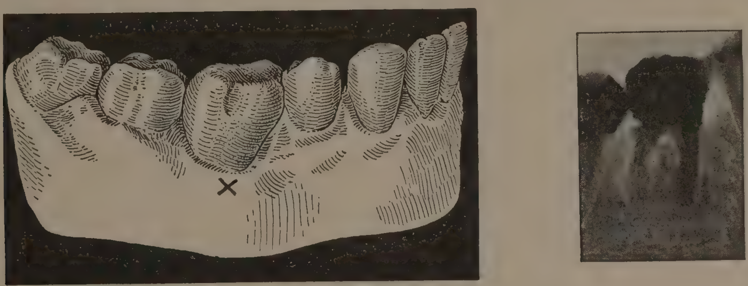


FIG. 382.

long before the tooth was lost. In the picture the distal root appears to have been partly absorbed, but such is not believed to have been the case. The gum receded, and this was true caries. Note the peridental membrane extends over this portion of the root.

Let us hope that some day some one will learn to perform the operation of replanting in such a manner that the peridental membrane will never be destroyed; whereupon, under those conditions, the roots will not become absorbed, and then replanted roots will last indefinitely. When that is achieved, it will be a great day in dentistry.

Transplanting of Teeth.—Transplanting is the operation of introducing into a fresh, natural socket, from which a tooth has just been extracted, another root, either freshly extracted or not. This operation also dates back to the days of Paré, but has now become obsolete. It is probably safe to say that no one performs this operation to-day.

Implanting of Teeth.—By this operation is meant the drilling into the healthy alveolar process, and the shaping of a socket therein to conform to the shape of the root to be implanted, and the implanting therein of such a natural root.

This operation was conceived and first performed by Dr. W. J. Younger of San Francisco. Unfortunately, while many teeth, that were carefully implanted, soon became firm and gave great promise, they proved to be of short life; thus the very high percentage of failures soon led the most enthusiastic devotees of the operation to discontinue its practice.

Many kinds of artificial roots were also implanted, but none were successful. As a matter of fact, the life of an implanted crib or artificial root was even shorter than that of a natural tooth.

In view of the fact that practically no one implants teeth these days, it is not considered necessary to occupy good and valuable "space" by a description of the operation. Should any one be interested, let him obtain a copy of the third edition of this work, in which he will find the technique of this operation fully described.

CHAPTER XXIX

PYORRHEA ALVEOLARIS

BY JOHN DEANS PATTERSON, D. D. S.

The work of writing upon the subject of "Pyorrhea Alveolaris" in a way to enable the dental practitioner to more successfully cope with that most distressing and destructive condition surrounding the dental organs becomes difficult only on account of the fact that members of the dental profession have so often been led to believe by many of the writers upon the subject that the disease is the expression of systemic conditions, and that until those conditions are corrected the treatment is well-nigh hopeless.

The operator who is a student of disease, if he gives credence to these statements is also well aware of the fact that the diseases of faulty metabolism, or those resulting in faulty metabolism—which, according to these writers, are largely causative of the condition known as "pyorrhea alveolaris"—are diseases rarely cured or even greatly modified; and we can then readily see that logically the operator hesitates to undertake a task which promises so little success to the operator or benefit to the patient.

At the outset of this brief consideration of the subject the author desires to state, with a confidence based upon observation and experience for over thirty-five years, that the condition or disease commonly known as "pyorrhea alveolaris" is amenable to treatment, effecting a cure as readily and satisfactorily as the other lesions of the dental organs, whether the systemic conditions which affect the progress of the disease are present or absent. The writer is not alone in this belief, as many careful observers and practitioners have proved in their clinical experience the correctness of the statement.

No sane member of the dental profession can rely upon cure in every dental pathological condition with an absolute precision nor can he promise that when a cure is brought about it will be permanent, for always a disease will again be reproduced when like conditions environ which produced the original lesion; but the chances for relief to the sufferer are as promising and as positive in pyorrhea alveolaris as the relief and cure following the process of filling a majority of carious teeth.

The prime object of this writing is to disabuse the mind of the student and practitioner of a belief in the incurability of the condition in question, and to teach that he should avail himself of all the ways and means to do this work, just as he does for the best methods of filling, crown- and bridge-work, inlay-work, or any other of the usual operative procedures, or he will not do his duty to suffering human beings.

GENERAL REMARKS UPON THE NATURE OF PYORRHEA ALVEOLARIS; ITS ETIOLOGY AND PATHOLOGY

Upon the best of authority it may be stated that the susceptibility of tissues to the attack of irritants of whatever nature varies greatly in different individuals; and that tissue character is largely of heredity. This is markedly observed in the oral mucous membrane. It is well known that a slight irritant in a given case produces distressing inflammation, and that in another case with the same amount of irritation the mucous membrane is scarcely prejudiced. A small point of calcic deposit which encroaches upon the gingival border at the cervix of a tooth will in one case produce pain and inflammation, and in another, larger amounts of calculus are not appreciable to the patient.

In a late edition of Stengel's work upon "Pathology" this predisposition of tissue to irritation is commented upon as follows:

"The normal system is able to cope with the determining causes of disease to a certain point by its general vitality and regulative functions." "The degree of resistance to irritation differs in different individuals in different races, or with people living in varying climatic conditions. In some the degree of resistance may be so great that certain diseases are never contracted. In other persons there is a recognizable weakness of resistance in one direction or another, which constitutes a definite predisposition. The latter may be either hereditary or acquired. By hereditary predisposition is designated abnormal weakness of resistance transmitted from father or mother to off-spring. They predispose to a number of allied affections. This is striking in the case of neuropathic heredity, in which various forms of nervous disease may appear alternately or irregularly in members of a family. In the occurrence of hemophilia we have another notable example."

The disease under consideration is observed by all careful clinicians to often affect each member of a family and their offspring, and the explanation must be found in the character of tissue which exhibits a weakness of resistance and which is handed down from one generation to another. It cannot be held, however, that this difference is always due to heredity, although it may be safely said this is generally true; for the tissue is brought to a weak condition at times, which has been

acquired. General debility from ill health and a starved condition of tissues from lack of nutritive supply frequently prejudice to the attack of irritants. It is quite doubtful, however, that the acquired predisposing conditions, which require usually a long period for the establishment of prejudiced tissue, is more than a minor factor in the causation of pyorrhea.

The mucous surfaces are ever under suspicion of certain characteristic inflammations and ulcerations, but it can scarcely be said that diseases like pyorrhea alveolaris have their inception without local irritation, whatever the predisposing factors may be.

For nearly half a century the most advanced pathologists have granted that even tumors no doubt have a local cause. Whatever the predisposition found in heredity or environment, yet without local irritat on of some description the proliferation of cells found in hypertrophy dioes not ensue. If investigators in pathology tell us this, well may put at once aside the claim often made, that the condition under consideration is *per se* of constitutional origin or caused by a specific micro-organism. Those who seek for the etiology of pyorrhea in obscure forces should return to the plain and provable logic of cause and effect, and forsake the speculative and unreliable. In the etiology of the condition the following statement may be safely made: *Any irritant, of whatever nature, which impairs the integrity and continuity of the gingival gum margin, may cause pyorrhea; and without this impairment the condition will not be established.* This may be followed by another proposition; viz., *Systemic conditions or a constitutional diathesis without local irritation do not destroy the integrity of the gingival border.*

The irritation which may dissolve the integrity of the gingival border may be presented in various forms. The deposition of the calcareous salts from the saliva upon the necks of the teeth is the usual form of irritation; next in importance may be classed the nests of putrefaction and fermentation about the gingival border and interproximal spaces; again, mouth-breathing dries the delicate border, and thus function is interfered with; and in all these irritations we have the protective reaction of inflammation against a common enemy—irritation. Other irritations may also be mentioned, and include most prominently, banded crowns, careless use of ligatures, the use of wedges, the presence of cavities holding food matter and which is wedged in the process of mastication into the interproximal spaces; also careless operative procedures. It is the firm opinion of the writer, however, that calcic deposits from the salivary secretions combined with food detritus, the nests of fermentation and putrefaction, the changes caused in the mucous membranes by mouth-breathing, the unnatural cervical tooth surface formed by banded crowns,

and proximal decay, must be considered the primal and usual causes of interference with and destruction of the relation of the gingival margin of the gum with the cervix of the tooth. The lesion of the gingival border is a result of *continued* (*generally long-continued* and persistent) irritation, such as is found under conditions above stated; and the factor of causation found in wedging, ligaturing, and other temporary interference with the gingival border consequent on operative procedures, can scarcely be cited as active causes for the establishment of pyorrhea alveolaris. In summing up the positive and possible causative factors in producing this disease, the writer's close observation of hundreds of cases confirms the statement that only a small per cent have other origin than that found in irritation from calcic deposits from the mouth-fluids combined with decomposing food remains.

When the first stages of the disease are established by a solution of the integrity of the gingival border from any one of the causes stated, the disease will progress, slowly or with rapid steps, until the tooth is eventually lost. The rapidity of the course of the disease will depend upon the amount of local irritation and the predisposition present; but without hygienic care, remedial measures, or surgical interference, it remains in the majority of cases but a question of time when the tooth investment will be entirely lost and the affected organ exfoliated.

Let us now trace more minutely the pathology involved from the first untoward symptoms.

With the initial lesion and the inflammation of the gingival border there is at once established the condition found in all inflamed territory—viz., the exudation of the contents of the nutritive vessels, which with the presence of micro-organisms eventually introduces the breaking up of the exuded vessel contents and the adjacent tissue into pus. There rarely is found an exudation which does not soon exhibit suppurative processes. This condition in which exudates and pus are exhibited gives rise to the precipitation of the calcic matter which is invariably present in all exudations, and is deposited wherever a convenient bursa for its reception is afforded. The explanation of the source of the serumal or sanguinary points and plaques found in pyorrhea is the simple and reasonable one, that in all inflammatory conditions there are exudations, and whether they are simple serum, as in the first stages, or pus, as in the later suppurative stages, there is in this matter calcium phosphate, calcium carbonate and magnesium phosphate, and in the changed environment these salts are logically precipitated, and thus form an irritant to the tissue about which it is deposited, inciting by its impact or touch, inflammation of soft tissue and absorption of bony tissue until the tooth organ is exfoliated. In the opinion of the

writer, the serumal deposits in pyorrhea are subsequent to the initial inflammation, and are directly from the inflammatory products.

In 1889, in a paper read before the joint meeting of the American and Southern Dental Associations at Louisville, Kentucky, the writer made the claim as stated above, and in substantiation spoke as follows (p. 172–173, Transactions of the American Dental Association, published 1889):

"Now, as a matter of fact, all prominent pathologists agree that accretions of calcic matter may make their appearance as a deposit from purulent matter from inflamed territory *in any part of the human body.* Upon this subject I desire to quote from the Hand Book of Medical Sciences, Vol. I, p. 743, as follows: 'Calcification consists in the abnormal deposit of earthy matter in or around the elements of a tissue, or *in the morbid product of a pre-existing inflammatory process.*' 'The circulation of the blood may be retarded and thus favor the precipitation of the calcareous matter which it normally holds in solution.' 'Calcification rarely if ever, depends solely upon general causes. There is always a local influence —very often it is due to a pre-existing inflammation. Old accumulations of pus, extravasations and exudations are exceedingly prone to calcification.' 'The simplest mode of explanation is as follows: A certain amount of calcareous matter is a normal constituent of the blood, in which it is held in solution by the carbonic acid always present in sufficient quantity to keep in solution twice the normal amount of earthy matter. When the circulation is impeded, the carbonic acid, because of its great diffusibility, is readily absorbed by the tissues, or goes to form new compounds, necessitating a precipitation of the calcareous matter. "*This is likely to occur in all tissues of the body.*"

After quoting the foregoing high authority, the writer said: "With these facts before us, does the presence of calcic deposits in the pockets of pyorrhea alveolaris still surprise us, and must we yet indulge in vague surmises over its origin?" What I said at that time is a firm conviction today. These deposits are from purulent matter and are the consequence of irritation and inflammation from the various local causes referred to. They are *not precedent* to a lesion, but invariably *are subsequent* to irritation and exudation.

The inflammatory process established with the precipitation of serumal calculus from inflammatory products, the continuation of the disease goes on to the breaking down of tissue as before mentioned, from the impact or touch—the mechanical irritation; and this force is supplemented by the presence of pyogenic bacteria, which in their life processes cause toxins, purulency, suppuration, which by gravitation and capillary attraction, infect and destroy the tooth investment. Soon there is noticed at certain points pockets of increased depth, and they indicate their presence

upon the gum by a reddish or purple line. Now the tooth often commences to change its position. It elongates, protrudes, or rotates—drawn by the remaining normal attachments, or by the protective reaction of tissues which seek to rid the economy of a diseased member. This looseness, and the consequent malocclusion, is also an irritant factor. These conditions soon cause a profuse formation of pus, which exudes about the teeth, and in deep constricted pockets the pus at times finds its way through the tissue at the lower point of the pocket and the abscessed condition points as in ordinary alveolar abscess.

When the disease reaches the apical territory, the nutritive vessels to the pulp frequently are deprived of their function, and the pulp takes on a pathological condition which results in its death; and so is added the additional irritation of common alveolar abscess. If the condition of pyorrhea is of long continuance, the root of the tooth in some cases is found to be attacked and absorbed in spots at the focus of inflammation. This has been noticed without the complication of the death of the pulp, though more frequently when the disorganized pulp tissue assists in the irritation. The giant cells often present in continued inflammatory territory in their strenuous attempt to protect tissues are found to destroy them. In pyorrhea the root of the tooth is occasionally observed indented in this manner immediately beyond the subgingival territory.

The above related conditions continuing unalleviated, the entire attachment of the tooth becomes diseased and obliterated and the organ is exfoliated.

In this brief description of the etiology and pathology of pyorrhea the writer has made no attempt to differentiate the various aspects found in the condition which are noticed, and which, in his opinion, need not be classed as distinct conditions simply because the degree of irritation and the degree of predisposition are different in the different cases and produce various degrees of destructiveness. A "true pyorrhea" and one that is not true is a distinction to the writer not warranted. Because in one patient the predisposition of poorly nourished tissue is present and an apparent (!) absence of local irritation, there is no reason why the condition should receive some specific name, when compared to a perfectly normal patient whose teeth are exfoliated by a disease whose pathology is similar. There can be no objection to denominating pyorrhea alveolaris "simple" or "complex," and when that is done, let us be content to observe its various phases exhibited when observed in patients who have various diatheses influencing its rapidity or destructiveness; but let us eliminate a so-called distinctive nomenclature for the various phases of this disease, unless it demonstrates a better scientific title to such distinction than is as yet made plain.

THE TREATMENT

Referring to the etiology of caries of the teeth, the late Dr. W. H. Atkinson once said to the writer: "We all have our differences of opinion as to the cause of tooth decay, but one thing remains true: That if we absolutely knew the cause, it isn't likely we could fill teeth a bit better." This leads me to remark that it is very fortunate that while writers, and speakers seem far apart upon the etiology of pyorrhea alveolaris, there is a great unanimity of opinion as to the treatment. Upon this we are upon comparatively safe ground, and upon consulting all, we find that whether the disease is considered systemic or local, hereditary or acquired, from degeneracy or faulty metabolism, syphilis or scrofula, catarrh or calomel, mouth-breathing or micro-organisms, ligatures or lithemia, indolence or insanity, wedges or whisky—the treatment is the same. Those who name the condition "interstitial gingivitis," "alveolar ulitis," "phagedenic pericementitis," "calcic pericementitis," "pyalogenic pericementitis," "hematogenic pericementitis," "infectious alveolitis," "odontolithus," etc., etc., agree almost literally in treatment with those who call the condition "Riggs' disease," or "pyorrhea alveolaris." There is a growing conviction among all that with the removal of all irritating and infectious matter from and about the teeth, and the maintenance of a vigorous oral asepsis, pyorrhea alveolaris, if not too far advanced, is curable.

DIAGNOSIS

To the inexperienced, rules by which a correct diagnosis may be reached, thus framing a ground for remedial treatment which will promise a cure, are well-nigh impossible; but it can be safely stated that if a tooth has lost three-fourths of its normal attachment, or exhibits a looseness indicating that nothing remains save a fibrous or ligamentous attachment, the loss of the tooth is usually inevitable and extraction is advised. It has been proved, however, that where it is practicable to place a permanent retainer upon such tooth or teeth, attaching them to those comparatively firm, freeing them from deposits, sometimes changing their position in order to stimulate repair of investment, and maintaining scrupulous hygienic conditions, even these ordinarily hopeless cases are given long life, and the patient is freed from the necessity of bridge work or plates. This must, however, be said: That the loss of teeth is far better than the continuance of those in the economy from which a pathological condition producing infection of good tissue cannot be divorced. Too many practitioners in the treatment of the dental organs, whether for pyorrhea or other morbid conditions of tooth roots, lay too great stress upon the evils resulting from a broken denture from extraction; even if substitution is possible, they

subject patients to discomfort and infection, often to an alarming extent, because of their horror of sacrificing a tooth, pretending to argue that mastication, digestion, and nutrition are thereby so interfered with that they choose the lesser of two evils. It must be patent to those of experience and observation that more than one-half of the human family manage very cleverly to exist, and in robust health, with a very limited masticatory apparatus. With a few bicuspids and molars more time is required for sufficient mastication that if the full complement of teeth is present; but it is nevertheless true that with care, a very few pounds pressure, and more time, the ordinary foods can be most properly prepared for deglutition. It is very comfortable to have teeth like a rhinoceros to champ and gnash with a pressure of hundreds of pounds; but the average citizen is not dockhand who must consume his meals in a few minutes, and if his choice grinders cannot be made confortable or sanitary by the best skill, then let them be as "the eye that offends."

When the diagnosis is completed and the hopeless teeth and roots are out of the way, the next step is the eradication of disease causes and disease results by surgical procedure; the all-important step, without which no amount of systemic treatment or no amount of local therapeutics will avail to cure or much alleviate the condition.

Preparatory to establishing the surgical work the operator should first obtain a complete history of each case. First as to heredity; find if there is a history in progenitors of loose teeth and loss of teeth without caries; find how long the condition has existed, the character of the discomfort, whether there has been annoyance from bleeding gums, swelling, or a foul taste or odor. Enquire as to possible acquired predisposition and as to what remedial measures or operative procedures have previously been instituted. Examine carefully with delicate explorers, mouth-mirror, radiograms and electric mouth-lamp all affected surfaces as to depth of the disease galleries and as to looseness of the teeth.

At this point the next question is to determine if the pulps should be removed from any of the affected teeth upon which operations are to be performed. Some years ago it was quite a popular belief that these affected teeth were in better condition for future usefulness minus the pulps. It was argued that after pulp removal the nutritive supply formerly going to the pulp was switched to the pericementum; so thousands of pulps were sacrificed needlessly and harmfully. Careful observers afterward came to the conclusion that in the treatment of pyorrhea a more rapid and more perfect cure was brought about when the pulp remained, and that the assertion of more nutrition and strength to the tooth's investment when pulp removal was practised was without scientific basis. It is, however, true that there are two situations in which the pulp should be obliterated

before further operative procedures are instituted: First, in case the diagnosis convinces that the pulp is in a pathological condition; and second, to afford anchorage for a permanently adjusted splint for retention. If in the progress of the disease the solution of the integrity of tissue at the apical territory has been accomplished, it may safely be said that the pulp is probably affected, its usefulness past, and it should at once be removed. Again, the irritation causing the pulp to be in a state of chronic irritation may be occasioned by the exposed condition at the cervix of the tooth or below it, on account of gum recession introducing thermal shocks. If this condition is present, the pulp should also be removed. In the second class of cases, the removal of the pulp in order to properly adjust an appliance to retain loose teeth, the operation should be, as in the former case, prior to the scaling operation, as upon the surface of the root from which the pulp has been removed the operation of scaling for obvious reasons is less painful.

There is yet another operation which frequently may be properly performed before proceeding further, and that is the making and cementing to place the retainer to be worn. This will guard against starting the tooth from its socket in forcing deposits away, and also prevent movement of the root causing pain.

RETAINERS

The operator's ingenuity will show him which of the great number of retaining appliances will serve best in a particular case. Many of the splints or retainers used in orthodontia serve admirably. The purpose of the splint or retainer is to prevent discomfort from movement, to obtain complete surgical rest, without which the formation of repair tissue is prevented.

Now commences the preparation of the mouth by the removal of all micro-organisms and fermentative or putrefactive matter by irrigation. First this should be done by the patient with warm water, followed by water at an increased temperature, up to 140° F. This should be followed by Dobell's solution, which is superior in removing remaining viscid fluids found in the mouth. Now the operator will follow with vigorous use of the syringe of strong force with blunt point, and following with a slim point which will enter the deep pockets and flush out all inflammatory products which are movable. After all possible poisonous micro-organisms and infectious detritus have been removed, the next step is to obtund the tissues to be operated upon, so that the operation may be rendered as painless as may be possible. The injection of the tissue is not advised.

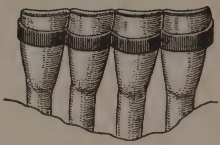


FIG. 383.

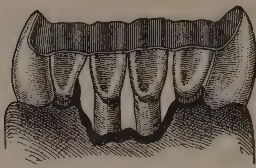


FIG. 384.

FIG. 385.

FIG. 386.

FIG. 387.

FIG. 388.

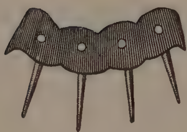


FIG. 389.

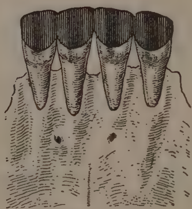


FIG. 390.

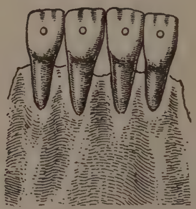


FIG. 391.

DESCRIPTION OF RETAINERS

FIG. 383 illustrates the commonly adopted method of retaining in a fixed position the lower incisors.

FIG. 384 shows a splint retainer.

FIGS. 385, 386, 387, illustrate the retention of the superior six anterior teeth. FIG. 385 the teeth devitalized and prepared to receive a strong post. FIG. 386 shows the retainer before adjustment. FIG. 387 the appliance cemented to place and completed.

FIG. 388 shows a method of retention for posterior teeth. Pulps usually removed and channels cut in the occlusal surfaces for a strong brace, the appliance is most satisfactory when the channel is filled as an inlay.

FIGS. 389, 390, 391 illustrate the author's original device for retention of loose lower incisors. FIG. 389 is the skeleton. FIG. 390 the lingual aspect after completion. FIG. 391 the labial aspect after completion.

The description and making of this retainer is as follows:—

Ligate the teeth firmly in the proper position. In cases of Pyorrhea very often the position of the teeth is changed, but they can be ligated and placed in the position desired. The next step is with the proper drills, a No. 1 round bur followed by No. 2, make a hole through the upper portion of the tooth, within about an eighth of an inch from the incisal edge which will accommodate 21-gauge gold wire. When these cases present we know very well the horn of the pulp has receded, so that there is little danger from encroachment upon the pulp. The next step is to take an impression with red base plate gutta-percha of the lingual aspect of the teeth, surround this impression and pour upon it the low fusing metal, which can be done in a very few minutes. In this way a very good model will be obtained. Swage upon that a piece of 22-karat gold plate 36 gauge, place it in the mouth, and indicate with an instrument through the holes where the pins should be. Punch the holes, place the wire and solder upon the lingual side. Then put it in the mouth and arrange it and burnish gold to fit exact. Use pure gold if desired. Remove this very carefully without changing its position. The reinforce with solder the lingual side until sufficient strength is gained. Before putting it on finally, grind or file the plate to the proper shape and polish, and when it is finally completed, place the rubber dam upon the teeth and cement it in place.

After the cement is thoroughly hardened, cut off the pins and rivet them with a round smooth burnisher in the engine, dress off the extra cement and the operation is completed.

There is no other appliance for the retention of the lower front teeth that is so delightful and permanent and that is so readily cleansed. All the gold that shows is the end of the 21-gauge gold wire, which cannot be seen by any one standing two or three feet from the patient.

[The above supposed original device for retention, the author finds should be credited to Dr. W. H. Trueman, of Phila., who described the same in *Dental Cosmos* of 1895, p. 607.]

OBTUNDENTS

For the purpose of obtunding, many preparations have been advocated and many methods advised. It is not our purpose to canvass all of them, on account of necessary brevity, but only to advise, after repeated trial, what seems most effective for the purpose. When the field of operation has been selected, dry the parts and pockets and saturate with the following mixture, for which we are indebted to Dr. Cravens, of Indianapolis:

"Put half an ounce of chloroform in a suitable bottle, add freshly pulverized hydrochlorate of cocain, shaking and waiting a few seconds after each addition of the alkaloid until the solution clears. To this add six to eight drops each of oil of cloves, cassia, and menthol, and add to all a flavoring extract to render agreeable."

This mixture seems greatly more effective in obtunding the tissue than all other cocain solutions used by the writer, and when placed upon a pledget of cotton and pressed into the interproximal space gently at first and then with force, the relief from the pain of removing the serumal deposits is marked. It may here be said that the strongest solutions of cocain may be used in the mouth for various purposes without danger of unpleasant results if the patient is instructed not to swallow one drop of saliva, but to eject every particle of mouth fluids. The mixture is also forced into the pockets with the delicate-pointed syringe, and thus penetrates deeper than when introduced with a broach wound with a shred of cotton.

Dr. Austin James, of Chicago, recommends a method of further rendering the use of scaling instruments less painful, by polishing all portions of the diseased root with various forms of wood points used in a porte-polisher and charged with pumice and phenol sodique, and burnishing with suitable forms of burnishers. A test of this method by the writer has given most excellent results. Before this polishing, if there are large plaques of salivary concretions, of course they should be dislodged. Dr. James also advises that only this polishing be done at the first sitting, and that in a day or two the sensitiveness will be less than if the instrumentation immediately followed the polishing.

SURGICAL TREATMENT

Now comes the instrumentation, and it may at once be said that the instrument which will accomplish the work of removing all deposits and irritant matter from the root, leave it smooth so that repair tissue will form about it, and do this with the least mutilation of the soft tissue, is the instrument to be advised. In all operations involving the gingi-

val tissue it is extremely important that the rope-like border surrounding the cervix of the tooth be not severed or mutilated, on account of the fact that with serious lesion it recovers slowly and is seldom reproduced like the original. So the instruments must be of a form, strength, delicacy and effectiveness not perhaps demanded for any other operation in dental surgery.

Until in recent years, the instruments used and advised have been chiefly those doing their work with a *pushing motion.* In 1886 Dr. G. V. Black, in the "American System of Dentistry," wrote as follows: "The instruments for this operation should for the most part be formed to work with a *pushing motion.* Curved and hooked instruments formed to work toward the hand with a *pulling motion* may be of service in removing the bulk of the larger concretions of salivary calculus, but they are of inferior value in the removal of the last portions of the deposits or for serumal deposits high up under the gum. For this purpose all hook instruments, no matter how delicately formed should be discarded, and slender points made to work with a *pushing motion* substituted."

The advice of Dr. Black, in the experience of all who sought to treat pyorrhea was deemed good; and while various instruments with a draw motion were formulated, they were found generally to be inadequate, and the *push* instrument first prominently brought to notice by the late Geo. H. Cushing with his admirable and delicate set of six scalers, and other sets with modifications of the Cushing forms, have been the reliance of nearly all who operated for pyorrhea. But the instrument with a *pushing motion* has had its day. Even the stoic cried out against it. It was the despair of those treating the disease with the *push* instrument to daily hear: "Well, my teeth can go; I'll never stand that pain again." Notwithstanding this, many patients appreciating the beneficient results, would return and submit to the subsequent minor operations often necessary to control the situation. In the meantime those who appreciated and demanded more humane instruments, upon the principle of placing a point beyond the deposits or other irritant matter and displacing it with a drawing motion, were continually advising and devising less painful methods, and with the result that more perfect results with less pain can be secured with properly formed hook instruments.

The dental operator has many times in the past expressed opinions denying the possibility of bettering methods and instruments, but subsequently they have been so improved as to bear little resemblance to what was once considered all that could be desired. The clumsy and impracticable instruments used by Dr. Riggs, which operators at that time thought were well-nigh perfect for the cure of pyorrhea, are now nowhere used save for removal of larger crusts of salivary calculus, and it seems to us an

astonishing thing that Dr. Riggs secured such a measure of success with them without first entirely dissecting away the soft and underlying tissues surrounding the root of a tooth. So now we find that the vaunted push instrument must give place to the more perfectly constructed draw instru-

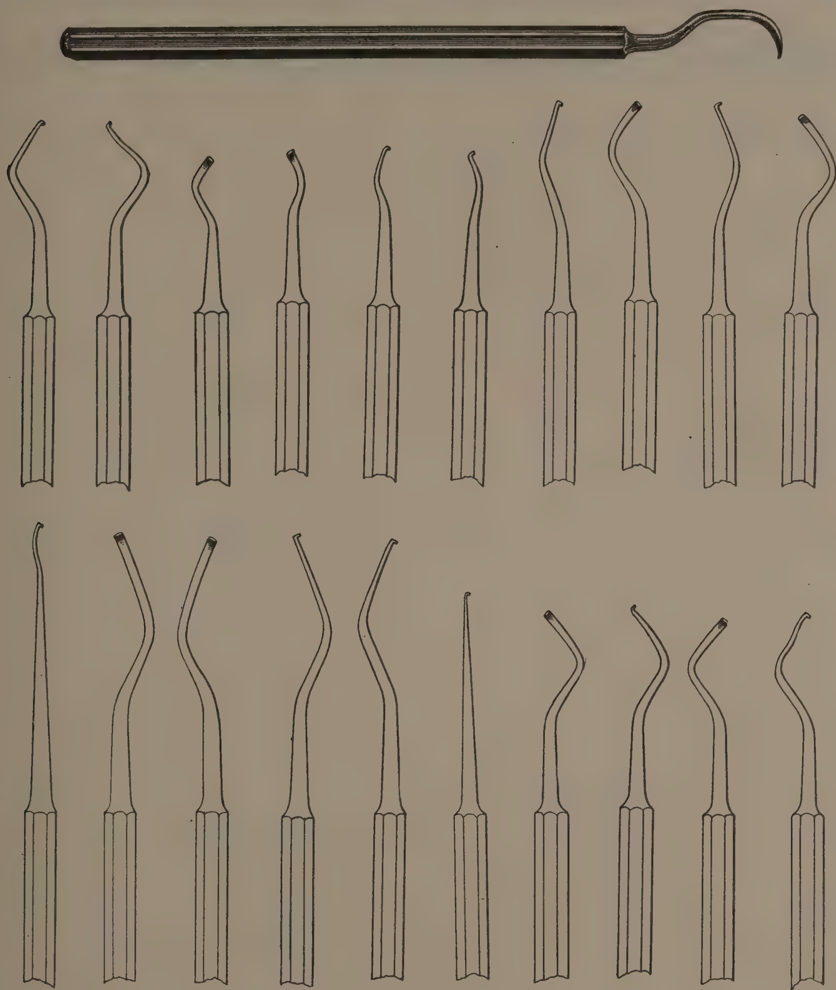


FIG. 392.

ment, which avoids pain and which leaves the surface of the root in a much smoother condition, insuring better repair of tissue.

The description and illustration of instruments for the treatment of pyorrhea alveolaris which have been evolved by various inventors, and which have led to more or less of success in removing irritant matter from the roots of teeth and brought a measure of success to the originators and

those who have placed reliance upon them, is not the purpose of this presentation; but it is the purpose to present in the following illustrations forms of instruments deemed greatly superior in effectiveness to any heretofore offered, their use causing less pain, and of such shapes that all surfaces of affected teeth can be scaled and smoothed, which, in the opinion

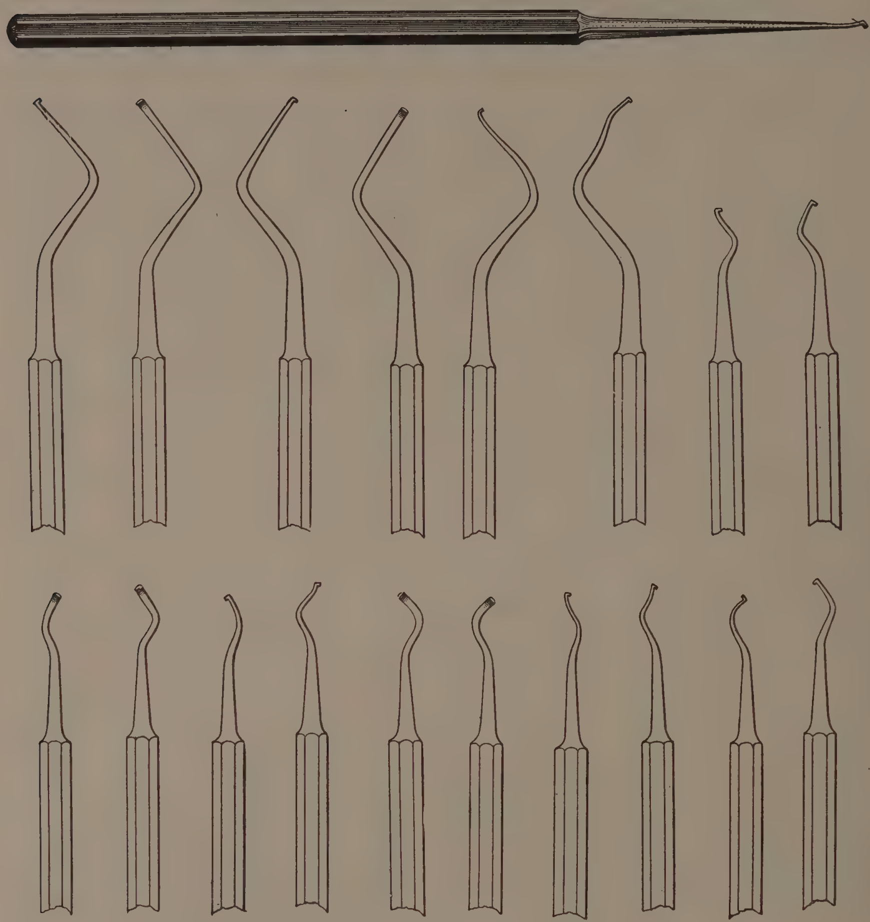


FIG. 393.

of the writer, cannot be accomplished with instruments heretofore commonly used for the purpose.

The principle upon which these instruments are planned can only be imperfectly described, but may be outlined as follows: The working point is a delicate yet strong hook, designed to be thrust beyond the plaques of calcic matter, which are drawn towards the crown of the tooth, thus dislodging and removing the irritant. Each instrument is so formed that a

short distance from the hook the blade rests upon the roots, and thus guides and steadies the working point, and also prevents undue furrowing of the root. The hook is rounded upon all corners and surfaces save upon the immediate or cutting edge, so as not to tear or lacerate the soft tissues. The great variety of forms allow the operator to follow the tooth contour with a minimum of pressure upon the inflamed tissue. Thus, the extreme apical territory can be reached and operated upon, if desired, with an entrance between the gum margin and the root of not more than a thirty-second of an inch, which is the usual distance from the working point to the back of the hook. These instruments have little spring, the great variety of shapes precludes that necessity, and the rigidity enables the operator to use great force, which is often essential in removing deposits which have long existed. The working point is constantly on line with the handle of each instrument; thus turning or slipping is prevented, and greater precision without undue force is attained. These instruments have but recently been placed upon the market. (Figs. 392 and 393.) The inventor is Dr. C. M. Carr.

The illustrations show some of the primal forms. In the full set each primal form has a number of variant angles and curves, with which different but allied contours of each root and cervix can be reached most perfectly and without unnecessary wounding of tissues. In beginning the operation of scaling, it is wise to select only that number of teeth for one operation which can be entirely finished at the sitting. If the disease is in the incipient stages, frequently a number of teeth can be treated; if the condition is in the advanced stages, from one to four should be the limit. In all cases each operation should be limited to an hour, for, in the first place, whatever the means used for obtunding, the operation is more or less painful; the teeth operated upon are also left in a condition acutely sensitive to thermal changes, and if many teeth are treated at one sitting, the discomfort is distressing for many days on this account, so it is surely best to confine this discomfort and the painful scaling to a limited time and a limited area to prevent accumulated discomfort in cervical territory on account of thermal irritation, and to prevent shock from the unavoidable pain of the operation. With the correct diagnosis as to the extent of the disease and the selection of the suitable instruments, there must be a determination upon the part of the operator that the roots selected to be operated upon at any sitting shall be entirely freed from irritating deposits and the surfaces left in a condition to encourage the new tissue of repair to form. The surgical part is not complete upon the removal of deposits, but after that these surfaces should be smoothed and polished as perfectly as may be. About the crowns and the cervix of the tooth engine instruments with brushes, strips, rubber cones, etc., of a great variety of shapes, are

applicable; beyond the gum margin hand instruments must be used. The various wood and other points, held in a suitable porte-polisher and charged with an abrasive, must reach all possible surfaces. Experience has taught that the time spent in smoothing the roots is well worth the endeavor, for the rapidity and permanency of the recovery is greatly enhanced, and the operation cannot be considered completed until as much time is given to the polishing as to the removal of deposits.

The polishing concluded, then comes the removal of all loosened detritus with the hot salt water used in a strong force syringe with slender special points which will reach well down into the pockets; these points are best made of silver or German silver, and can be fashioned by any instrument-maker.

MEDICATION

The Pharmacopeia has been searched for the drugs which will best assist to a cure. Each operator has a favorite remedy among the germicides, antiseptics, or stimulants. Some form of an acid has strong supporters; those usually relied upon are sulphuric acid in the form of the aromatic, and lactic acid. There can be little doubt of the efficacy of the acid treatment for the removal of broken-down tissue and the stimulation of involved alveolar processes, but there is a very grave objection to the use of the acids, on account of the fact that the exposed necks of teeth re thereby rendered more sensitive to thermal shocks. The surfaces from which the coating of deposit is removed in any event are a source of great discomfort to the patient in whatever manner they may be treated, and as the acid treatment seems to greatly increase this tenderness, the writer has abandoned its use and substituted a 10 per cent solution of silver nitrate, which, as is well known, renders those surfaces much less painful. Indeed, in very depraved conditions and pockets of this disease, when the discoloration is not an objection, a saturated solution of the silver nitrate brings results not secured with other drugs. The 10 per cent solution is just short of the discoloring strength. In using the silver solution the parts should be protected from saliva for a few seconds. After this treatment all inflamed and diseased gum tissue should be bathed with drugs or combinations of drugs which stimulate absorption, act as counter-irritants and obtund irritated surfaces.

This completes the surgical treatment, and if the different proceedings described have been faithfully performed, the cure to be in time established now rests largely with the patient. This is an all-important consideration, for it is patent to all that the disease will recur if conditions permitting the original trouble are not entirely corrected. *Each patient must be thoroughly imbued with the plain statement that however faithfully the surgical operation*

has been, there can be little hope of more than transient relief unless there is a determination that the mouth must continually be kept in a sanitary state. Observation has taught us how hopeless often is the task of changing habits which are ingrained during a lifetime and betoken a lack of physical cleanliness. Patients suffering from pyorrhea *must be taught by positive and sometimes abrupt but earnest words*, that when they declare their mouths receive the most scrupulous care, they are simply deceiving themselves, and that the supposed care must be doubled and trebled ere a hygienic mouth condition will be present. They must especially be warned that the mouth must be cleansed of food detritus after each meal, and that once during twenty-four hours brushing with unlimited use of a powder for three minutes must faithfully be performed. The usual and universal swishing and dabbing for a few seconds upon only the buccal surfaces must be shown to be well-nigh useless, and that especially the lingual and interproximal surfaces are the points most needing friction. The position of holding the brush and the cleansing movements can best be shown upon the

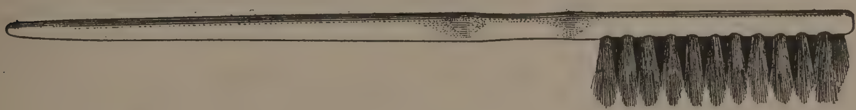


FIG. 394.

actual teeth in a skeleton or dummy. The brush recommended is one in which the tufts of bristles stand well apart, admitting their reaching between the teeth, and is illustrated in Fig. 360. After the brushing, show in the mouth how the gums should be massaged with the finger and thumb, firmly pressing the receded gum toward the cervix, thus pressing foreign matter out of pockets and coaxing it to its original anatomical position. Finally, direct that nothing is equal to the cleansing and exercise and scouring in mastication of fibrinous foods, and that the more sensitive the gums are the more the teeth need their natural use. There is scarcely a dental arch affected with pyorrhea where one-half of the arch does not exhibit great difference in the disease progress, and it will be found that the worst condition is invariably upon the side not used or little used in mastication. This neglect of universal use comes of habit, but more often because of a defective arch or tenderness in teeth or gums. Patients must be instructed that safety lies in the use of *all* teeth, and the operator must see to it that he has rendered that possible not only in correcting the gum disease, but in making faulty arches as perfect as may be possible. The frequent use of a mouth wash, preferably a salt solution, for rinsing, and to be forced into the interproximal spaces with a blunt-pointed strong force syringe, should also be instituted. A trial of the syringe for home

treatment will soon convince any observant operator that therein he has a great help toward a cure. It will be found that after the most vigorous rinsing and brushing, food particles and matter in the imperfect interproximal spaces are dislodged with the syringe which were undisturbed with the brush. Especially is the syringe to be used until repair tissue fills the pockets of disease with new material.

SUBSEQUENT TREATMENT

If the operation has been well done, it is inadvisable to disturb the pockets, which are soon filled with the plasma out of which repair comes. The very common practice of frequent probing and medicating is *strongly condemned*. Give Nature an opportunity to do the mending, and do not stab the protoplasm thrown from the nutritive vessels with medicine or touch. In sixty or ninety days examination should be made, and if any point of calcic deposit has escaped the initial operation, its position will be easily indicated by an inflamed tissue. This examination will also determine as to the degree of care being given by the patient. If it is found to be very lax, prove it so by asking the patient to take the hand glass, and with a suitable instrument remove the cheesy putrefactive matter, which can only remain under careless brushing. Then comes your opportunity for a lecture containing few words, but they will be emphatic in explaining the uselessness of any possible surgical operation unless followed by directions originally given. Sometimes we find those instructions entirely forgotten and their repetition asked. On the other hand, do we find that great care has manifestly been observed, never fail to give warm compliment.

SYSTEMIC TREATMENT

When pyorrhea is accompanied with any predisposition, whether hereditary or acquired, which lends to the virulence of the disease, such systemic treatment for the correction of the predisposition as found advisable should always be relegated to the patient's medical adviser. It is a breach of ethics if the doctor of dental surgery invades the general field of medicinal treatment by the administration of internal remedies for the correction of faulty metabolism or systemic conditions from whatever cause.

CHAPTER XXX

EROSION

By JOHN ALBERT MARSHALL, M. S., D. D. S., PH. D.

By the term *erosion* we seek to define that abnormal condition of exposed tooth surface which is characterized by superficial circumscribed concavities, highly polished, frequently geometrically shaped, and without apparent evidence of decalcification. Authors have applied different terms to this condition, such as, absorption, (1) denudation, (2) and (incorrectly) attrition, abrasion, and hypoplasia. There is a good deal of uncertainty relative to the origin of erosion and among the many theories which have been advanced those relating to a hyperacidity of salivary secretions in conjunction with a definite abrasive action of polishing powders, or agents, appear to be more generally accepted. The lesion may commence at "numerous irregular points on the labial surfaces of the teeth which extend and after a time coalesce, involving loss of the entire enamel wall of the surface," (2).

Hunter, in an article "The Decay of the Teeth by Denudation," was probably one of the first to describe erosion. Magitot emphasizes the fact that these areas are clean, polished surfaces which may be notched or which may have other forms depending upon the progress of the disease.

Other types of so-called erosion are those described as being symptomatic of certain deficiency diseases. Abt and Frank (3) refer to a case of "erosion" associated with rickets, but in this particular instance the term hypoplasia appears to more nearly represent the facts. The teeth showed traces of punctuate depressions which indicate a condition of under-nourishment during the formative stage of the teeth. Erosion does not define under-nourishment of a part, but is taken to refer expressly to the *wasting* away of a previously formed organ. Similarly in those cases of congenital syphilitis the hypoplastic, or Hutchinsonian teeth, often found associated with this condition are erroneously classified by some authors as eroded teeth (4).

ETIOLOGY

Kirk (5) has investigated erosion, and he describes two different classes of the condition; the first, the so-called "general," and the second,

the "graphic." In the first division he includes those cases "in which all the surfaces of the teeth are uniformly involved, and in which lactic acid is the solvent . . ." The other class he believes is distinctly the result of the erosive exudate from abnormal buccal mucous glands. The acidity of the secretions is due to one of two things, either the presence of free acid or of the salts, "the acid sodium phosphate or acid calcium phosphate." Kirk's investigation was based on sound physico-chemical principles. His object was to separate by dialysis the colloidal constituents of the saliva from the crystalloids and by subsequent chemical analyses of the dialyzate to determine the nature of the inorganic salts. From the formation of the different salts, as shown by crystallization, Dr. Kirk concludes that the "localized cases are produced by an abnormal mucous exudate containing either of the two solvents, namely—acid sodium phosphate or acid calcium phosphate." Since this theory was published there have been many advances in the field of physiology, and especially in that field dealing with the acidity and alkalinity of tissues and tissue fluids. For example, it has been shown that blood possesses within itself the power of controlling or of regulating its degree of acidity or alkalinity. Similarly, the saliva which is derived from blood exhibits an analagous property. In fact Marshall (6) has proved that this phenomenon as it occurs in the saliva depends upon the interaction of certain inorganic compounds. The substances controlling this reaction have been termed "buffers," and they function as alkaline or acid reserves. When an undue alkalinity occurs in the mouth, as, for example, in the use of a strongly alkaline mouth wash, the acid phosphates and bicarbonates in the saliva tend to reduce this unusual condition and return the saliva to normal reaction. Neither the blood nor the tissue fluids depart very far in their degree of neutrality. Henderson (7) has shown that "not more than five parts of excess free *H* or *OH* ions can be present in ten billion parts of protoplasm," and Wells (8) states that "the interchange between CO_2, phosphates, and carbonates in the blood is such that it is impossible for any *considerable quantities* of the free *H* or *OH* ions to exist, and the protoplasm is thus protected from an excess of either." It is this problem of neutrality of saliva which has been studied by Marshall and his results are in conformity with those reported by the authorities quoted above, upon the reaction of the blood.

In considering the acidity and alkalinity of saliva it must be remembered that this term is only relative. In the tissue fluids there are always present those substances which are acidic, and others which are basic. Carbonates and bicarbonates, basic and acid phosphates are examples of these salts. That they occur in different proportions has been demonstrated by the so-called "buffer action" of tissue fluids. This buffer action is responsible for the maintenance, within relatively narrow limits,

of the neutrality of the secretions of the body. It has been suggested in the past that the presence of acid in the mouth could be detected by placing a piece of litmus paper on the teeth or on oral mucous membrane and observing whether the fluids caused the test paper to become red. Litmus paper is of course very susceptible to carbonates and to carbon dioxid, both of which occur in quantity in saliva, and, therefore, a test which does not recognize and eliminate or measure this reaction is worthless. Conclusions or generalizations which are based on such experiments with litmus cannot always be accepted as correctly representing the conditions.

The reaction of the basic and acid phosphates as given by Dr. Kirk, however, namely

$$H_2CO_3 + HNa_2PO_4 \rightleftarrows HNaCO_3 + H_2NaPO_4$$

expresses in part, at least, the facts as we recognize them today. His researches also indicated that the lactates or lacto-phosphates produce a definite effect upon the inorganic portion of the tooth.

Miller was not in entire accord with the conclusions of Kirk, and he reports that he could not obtain a typical eroded area by using different solutions of varying degrees of acidity. By combining the abrasive action of a toothbrush, however, with the erosive action of chemicals he was able to similate this condition of erosion. The work of Miller does not permit of a definite differentiation between mechanical and chemical factors, for he ascribed to the use of both gritty toothpowders and weak acids the power of producing this lesion. We may assume that an experimental type of erosion can be produced, as Miller concludes, only "by the combined action of acid salts or acid substances together with a mechanical effect, such as is obtained by vigorous brushing of the teeth." Acids or acid salts which occur in a concentration sufficiently great to effect solution of inorganic tooth structure may be properly considered as a factor in erosion. The organic material is more easily attacked by alkaline salts, and, therefore, any alkaline salt or base which is present in sufficient quantity may likewise be considered in the etiology. This constitutes another differentiation between erosion and caries. Although the former is characterized by a highly polished surface, on which there is no evidence of decalcification or of a decomposing matrix, the latter may exhibit both of these phenomena depending upon the progress of the disease.

Cook has suggested that *mucic acid* is responsible for erosion. He attributes the origin of this complex organic acid to galactose by assuming that this carbohydrate is broken down or oxidized in the body in such a way that the acid is one of the decomposition products. Although all the facts concerning the metabolism of mucic acid and galactose have probably not been worked out, there have been at least two researches

reported, the results of which are not in accordance with Cook's theory. Galactose is found in small amounts in milk; and in the laboratory, at least, it may be derived from other sources. It is known for example, that some of the lipoids (fat-like bodies which occur naturally in the human body), may be split apart chemically with the addition of water, (hydrolyzed), in such a manner that a reducing sugar is set free. The galactosides, which constitute one of the classes of lipoids, may be so hydrolyzed and galactose obtained. The further decomposition of this sugar into mucic acid is readily accomplished in the laboratory by nitric acid. However, up to the present time this hydrolytic cleavage of galactosides into galactose and then into mucic acid has been accomplished *only* in the *laboratory*, and there is no evidence to indicate that this phenomenon occurs within the animal organism. In fact Rose (9) has conclusively shown that mucic acid is not a product of the physiological metabolism of galactose. McCollum (10) in addition to this states that D-galactose "has never been found in the free state in either plants or animals." It is apparent, therefore, that the theory of Cook upon the occurrence of mucic acid is not in accordance with all of the biochemical facts. Although mucic acid may be oxidized indirectly from galactose (a monosaccharide), there is no evidence at the present time that this reaction occurs normally in the animal organism. The polysaccharides, disaccharides, and *monosaccharides* are hydrolyzed into the circulating form of carbohydrates, namely, *glucose*. This glucose is either used at once or eventually is resynthesized and stored as glycogen, but at no time during this synthesis has any evidence been obtained of the presence of *free mucic acid*. The application of Cook's theory demands this proof.

Preiswerk (11) expresses the opinion that erosion is caused from an indirect result of the activity of the flora of the mouth. He conceives the process to be somewhat as follows—certain bacteria possess the power of producing substances, "enzymes," which act upon the organic material in the tooth structure. This is dissolved and the calcium set free. Subsequent muscle movements in mastication and talking are responsible for the removal of the tooth substance which has been disintegrated. If erosion occurred with the same degree of regularity on exposed cementum as it does upon enamel, this theory of Preiswerk might appear more logical. It seems difficult to accept as a hypothesis one which depends upon the preliminary solution of a constituent which is present in so small an amount (3 per cent), as the organic substance found in enamel. The histological conception of enamel is one which recognizes the presence on the exposed surfaces of an inorganic material rather than an organic one. The organic reticulum is embedded in lime salts, and, therefore, an agent

which would react upon the fibres must first free them of the overlying calcified portions of the tooth. If we recall the fact that enamel contains approximately 3 per cent of organic material and cementum 28 per cent we would expect to find an agent, in the case of enamel at least, which is more active on the inorganic substance than on the organic.

Black (12) summarizes eight possible factors which may be concerned in causing erosion of the teeth. In this etiology there is some apparent confusion between erosion and abrasion. Hypoplastic conditions resulting from mal-nutrition during developmental periods, may, according to Black, be definitely concerned in producing eroded areas at later periods in life. Another hypothesis is that based upon an analogy between the resorption, which we know occurs upon the roots of deciduous teeth and the absorption of enamel of the eroded area. The process in the case of the deciduous roots is believed to be due to pressure of the erupting permanent teeth, but it is not apparent why these cavities should occur at the necks of the teeth merely on account of the pressure of the overlying buccal mucosa.

Bennett (13) differentiates erosion from abrasion and attrition by classifying the position and shape of the cavities in the enamel. Other writers upon the subject are not in entire accord with the various opinions expressed concerning the phenomena apparent in these three conditions. Most of them agree with Bennett, however, that hypersensitiveness appears to be more acute in the advanced stages of erosion than in the case of the purely mechanical processes of abrasion and attrition. By attrition is meant more particularly the gradual wearing away of the calcified portions of the teeth "through the physical and physiological agencies of mastication of food." The teeth of pre-historic man commonly presented the evidences of attrition. Abrasion refers to a third process and may be taken to mean that condition of rapid destruction of enamel and dentin by friction. The presence of foreign bodies in the mouth is responsible for this mechanical effect, and the abraded surface is rough and may be deeply stained. In erosion, however, the surface is highly polished and unstained.

SYMPTOMS

The portions of the tooth showing erosion are usually the labial and buccal surfaces in both jaws, but the upper teeth are more frequently affected than the lower. The lingual surfaces are involved only in rare instances and there are no records describing erosion on the interproximal surfaces. Even when the buccal or labial aspects are eroded, the lesion does not usually encircle the tooth, nor does it cross from one surface to another. The shape of the area varies within a relatively wide limit—it may be cup-

shaped, wedge-shaped, crescent-shaped, or consist of irregular grooves. In the first stage the erosion is confined to the enamel, and aside from the existence of a very smooth depression, there is scant clinical evidence of the lesion. Later the dentin and in rare instances the cementum show the effects of the wasting process. The diagnostic symptom which differentiates erosion from caries is, that in the former instance, the affected surface is highly polished and without evidence of decalcification. In caries, there is a roughened area which appears decalcified. In those instances in which the progress of the diseases has been rapid, the tooth is hypersensitive to tactile irritation. Heat and cold do not appear to produce the same character of pain. When the process of denudation is slower, the pulp may protect itself for a time by undergoing a degenerative

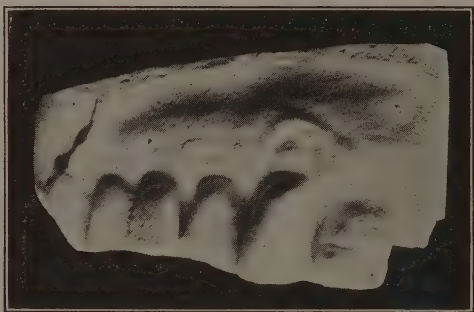


Fig. 395.—A Typical Case of Erosion.

tubular calcification, and as a result the eroded area becomes relatively insensitive.

Clinical data upon the frequency of erosion are not complete. Black states that his inquiries indicate that erosion occurs more often among the wealthier patients. There is some evidence, also, that the Jewish people are more susceptible than Gentiles. Inaccuracies of clinical records are such, however, that other authors fail to recognize any influence of race, sex or environment upon the frequency of erosion.

TREATMENT

Although in many instances attempts at prophylactic measures have been made, the degree of success realized has not been entirely apparent nor commensurate with the effort. It has not been found possible to arrest the progress of the disease in all cases, nor to establish an infallible cure. The remedies which have been recommended by authors include the use of alkaline mouth washes, alcohol in various concentrations, zinc chlorid preparations and silver nitrate solutions. A radical change in the prophylactic measures, which the patient usually practices, is sometimes

advocated; instead of the toothbrush with stiff bristles the patient may be directed to employ as a substitute an orange wood stick on which has been wrapped a piece of cotton. Since the labial and buccal surfaces are usually the ones affected, this prophylactic procedure is not difficult of accomplishment. The other surfaces of the teeth are cleansed in the usual way by means of the toothbrush. Some evidence has been collected which tends to discredit the use of certain tooth powders and pastes, but confirmation of these observations is difficult to obtain.

The most successful method for the treatment of erosion consists in placing gold fillings, porcelain inlays or porcelain jacket crowns. The proper excavation of the eroded surfaces is particularly difficult in those cases where the teeth have become hypersensitive and even the use of a local anesthetic is not always efficient in relieving the pain. Erosion does not extend under the free margin of the gum but develops only on the exposed surfaces. It is not so necessary, therefore, to adhere closely to the principle of extension for prevention when preparing cavities for filling. Silicate cements may be placed to advantage many times in these cases for not only is less cutting of tooth structure necessary but the fillings appear to maintain their integrity for a long period of time. It is the experience of many operators that the wasting process continues in the more severe cases, even after the most careful restorations have been made. Finally the filling may be completely encircled by a new eroded area, such as is illustrated in Fig. 396.

FIG. 396.

The local treatment of erosion should consist of restoration of tooth surface and any effort at systemic treatment is ill-advised until more data have been collected upon the present obscure etiology. The use of alkaline mouth washes such as a suspension of magnesium hydrate (milk of magnesia) or sodium carbonate, or phosphate, does not appear to be warranted from our present knowledge of salivary reaction. While it is true that these agents would neutralize any local accumulation of acid, it is to be pointed out that the concentration in which they are customarily used is far in excess of that which is necessary to effect this neutralization. The acidity of salivary mucin is very, very slight. And if it is conceded that an excess of mucin *is* an important etiological factor in this disease, it would not be necessary to use any such quantity of alkali as has been recommended.

Our knowledge of the etiology and, therefore, of the correct treatment of dental erosion is in the same state of uncertainty that characterizes the etiology and treatment of other dental diseases. But to the author, at

least, the clinical facts and the experimental data which have been collected thus far are at such direct variance with each other that the study of this problem is of unusual interest.

Further research must include not only a chemical study of the oral secretions, but must embrace as well the histological investigation of the tissues themselves.

1. Burchard & Englis, Dental Pathology and Therapeutics, 6th Ed., 1920, Lea & Febiger, New York.
2. Marshall, J. S., Operative Dentistry, 5th Ed., 1920, J. B. Lippincott, Philadelphia.
3. Abt & Frank, Rachitic Erosions of the Permanent Teeth Associated with Lamellar Cataract, J. A. M. A., LI, 14; 1130; October 3, 1908.
4. Barlin, J. K., Erosion of Teeth in Children, *British Medical Journal*, II, 71, Sept. 21, 1895
5. Kirk, *Items of Interest*, XXIV, 511, July, 1902.
6. Marshall, John Albert, *Amer. Journ. Physiology*, XLIII, No. 2, 212, May, 1917.
7. Henderson, *Amer. Journ. Physiol.*, 1907 (18), 250; 1908 (21), 427.
8. Wells, Chemical Pathology, 4th Ed., Saunders, Philadelphia, 1920.
9. Rose, Wm. C., Mucic Acid and Intermediate Carbohydrate Metabolism, *Journ. Biochem.*, X, 1911–12, 123.
10. McCollum, Medical Organic Chemistry, McMillan, N. Y., 2nd Ed., 1920, 317.
11. Preiswerk, *Zahnheilkunde*, 1903; 200.
12. Black, G. V., Operative Dentistry, I, 1st Ed., 1908, Medical Publishing Company, Chicago.
13. Bennett, Norman G., Science and Practice of Dental Surgery, Oxford Medical Publication, 1914.

CHAPTER XXXI

THE MANAGEMENT OF AN OFFICE PRACTICE

BY ELLISON HILLYER, D. D. S., SC. D., F. A. C. D.

When college and state board requirements have been fulfilled the graduate student faces the problem of applying the result of his preparatory training to its ultimate object—the practice of his profession.

Two paths open before him; either he may enlist as the assistant of another practitioner with the aim of acquiring by close contact that experience which only the atmosphere and surroundings of an office can give or he may elect to begin at once his career upon his own account, relying upon his college training as sufficient. In either case it is but a beginning and each should feel that nothing but an assiduous devotion to the highest ideals and constant pursuit of further knowledge can lead to any measure of success.

By the time a student has received his degree and license to practive he should have learned to regard his profession as among the most dignified and worthy of all he can give to it. If a student regards it as but "a means to an end" he should press the question further and ask himself "what is the end?"

He has probably heard it said many times that he will hardly grow wealthy by the practice of dentistry alone; if wealth is what he seeks, then let him choose some other path. The status of the profession was never elevated by one of its members seeking affluence through its channels but it has been raised to its present high position by the self-sacrifice of *those who have given more to it than it to them.*

Imbued with this spirit and settled in conviction as to just what "success" really means, let each go forth prepared to do all in his power for those who will come into his care; let him remember that he has been trained to serve and that it is his place to give the best that is in him with no thought of the public as existing for his benefit.

Were this spirit to animate all our graduates the quackery which is the bane of our profession, as it is of all professions, would cease to exist. The beginner argues that "he must make his living" and proceeds to make it by whatever means present. This is short sighted as no great success, in the highest sense, was ever achieved by lightning strides but

by slow consistent proceeding. Thus only can a man hold his place as a professional man. If he prefers to prostitute his ideals and make of his profession a "business," with fillings and dentures at so much per filling and denture—that "so much" being usually as much as he can make the patient pay—he must be satisfied to take his place outside the professional pale and realize he has none but himself to blame.

In the locating of his prospective office the student has to consider several things; surroundings, ease of access, availability of space and arrangement of reception and operating rooms. Of the first two nothing need here be said; of the latter much might be noted.

For the best results three rooms are needed; the reception room, operative office and prosthetic laboratory. To the first may well be added a retiring room fitted with various toilet requisites. The reception room should be made as attractive as possible. The general atmosphere should be one of refinement and good taste with everything to detract from the unpleasant side of a visit. Good literature, magazines and books should be at hand to occupy any spare moments of a waiting patient. Attractive fittings and interesting pictures should be provided to catch the eye and by suggestion take the attention of the patient away from himself. Have some one—preferably a lady—in attendance, as much more ease is given to both patient and operator by the judicious services of a competent lady assistant.

In the fitting of the operating room two plans are offered; one upon the design of a general surgical operating room, accomplished by having a cement or inlaid floor, enameled walls and ceiling, enameled iron chair with leather fittings, enameled iron cabinet, etc., with glass for all shelf work. While white enamel is usually chosen, any color scheme in enamel may be carried out in the finish of chair, cabinet and operating apparatus. These fittings are all obtainable and make an admirable outfit for anyone who cares to go to that extent.

The other plan admits of cheerful surroundings; hard wood floors with rugs, pleasing draperies and pictures with the use of glass *wherever instruments are to come in contact with tables, brackets, etc.* Several illustrations of offices may be found in the pages of the *Items of Interest*, Vol. XXI, which would give many valuable ideas to beginners regarding the fittings of an office.

Difference of opinion exists as to the proper size of the operating room; this need be no larger than is required for the operator to stand by the operating chair within easy reaching distance of the instrument cabinet, dental engine apparatus and electrical equipment; much time is saved by having everything within easy reach. When a larger room is used *this same arrangement should still be maintained about the chair*

while other appurtenances, such as an office laboratory work-bench, tables for porcelain furnaces and an office desk may be introduced.

While many beginners may not plan to make a start in what today is considered a thoroughly equipped dental office, yet sooner or later each will come to the point where he will desire to so equip his office and he will find many labor and time saving devices at his disposal.

Electricity admits a large field of application, used as it is in the

FIG. 397.

dental engine, lathe, sterilizer, annealer, heaters of various kinds, syringes, both air and water, cauteries, etc., to say nothing of the light, illuminating the room and providing by low power lamps for oral, and by higher power for antral examinations.

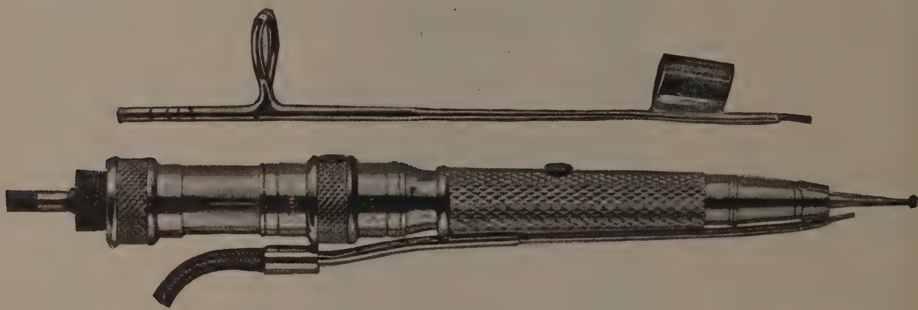
Compressed air is another most useful ally. A convenient tank of the capacity desired may be placed either within the operating room or in a place as far removed as the operator wishes. This tank may be filled by means of either hand, foot, electric, or hydraulic pump (Fig. 397). The

latter two keep the pressure at the full capacity of the tank—operating automatically as the air is used.

The uses of compressed air are legion; primarily, with the air syringe attached, any force—up to the capacity of the tank—may be registered upon the dial. If this syringe be supplied with the hot air electric coil attachment, by the turning on of the current, regulated to any degree of heat desired, the air becomes a warm blast.

A very practical compressed air syringe attachment is manufactured by L. Green, of New York, N. Y. (Fig. 398). It was first introduced, as far as the writer knows, by Dr. C. Edmund Kells, of New Orleans.

It consists of a very fine silk covered rubber tube, leading from a controlled outlet to an atomizer nozzle attachable to the engine hand-piece.



Above cut shows its application to the hand-piece

FIG. 398.—Engine Hand Piece—Chip Blower.

This instrument keeps the field of operation free from débris, permits of continued operation, thereby shortening the time at least 50 per cent. It also minimizes the pain produced by the heat due to the friction of the burr in excavation.

This gives a direct blast of air upon the surface requiring operation, freeing the area from débris of cutting and acting as an obtunder by overcoming the heat incident to the friction of the bur in cutting.

Both electricity and compressed air may be controlled upon one switchboard (Fig. 399) within reach of the operator's hand while standing at the chair.

In choosing an instrument cabinet certain things should be considered, whether the cabinet be an inexpensive or a costly one; compactness, adaptability to personal needs, and, if fitted for medicines, that there should be provided for them a separate compartment—one which will as effectually as possible prevent any odors from escaping. Many practitioners keep medicaments in common use in their respective vials under a glass cover. No office is attractive if permeated with odors of any kind and the greatest care should be exercised to prevent their presence.

Running water is essential in the operating room. Fountain cuspidors may be obtained in great variety, suited in price to any purpose, and offering

one of the most indispensable aids to the operator. This may be stationary or attached to the chair. A wash basin should be in plain sight that

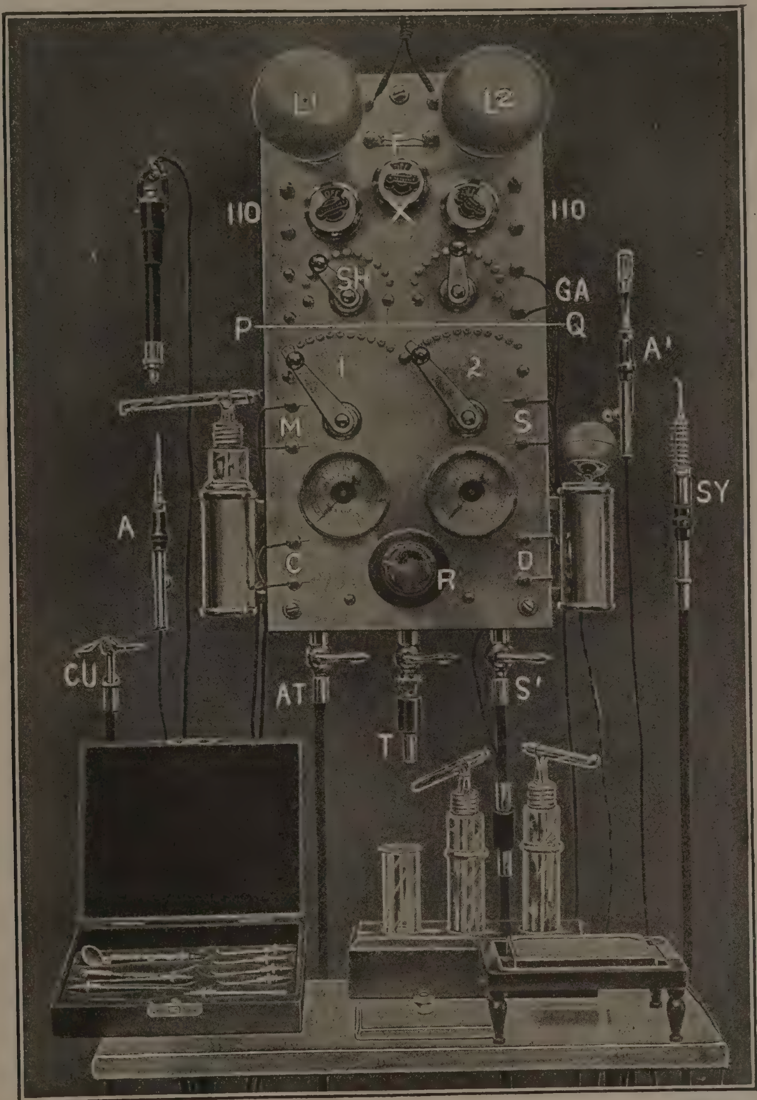


FIG. 399.

the patient may be assured that the operator follows out the necessary ablutions before each operation.

The most convenient and compact arrangement for combining the dental engine, electric equipment and fountain cuspidor is now provided

FIG. 400.—Developing the cabinet provides a portable dark-room of great convenience for dentists who wish to do their own work but have no available space for a dark-room.

The Cabinet is a miniature dark-room complete with tank developing outfit, safelight and connections for circulating water.

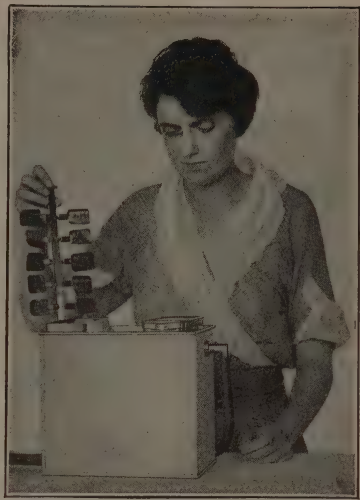


FIG. 401.—The Tank Outfit.

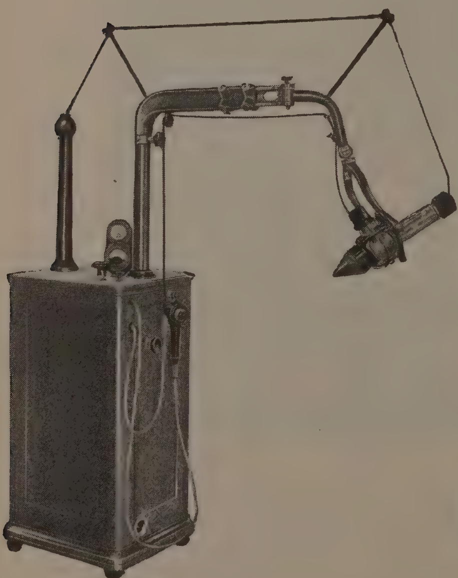


FIG. 402.—The Ritter Dental X-ray Unit.

FIG. 403.—The Ritter Dental Unit.

by many manufacturers in what is termed a "dental unit" (Fig. 403). This provides the most satisfactory method of concentrating in small space practically all of the necessary equipment.

The development of the X-ray in dental practice has progressed to such an extent that no office is complete without some type of machine. These range from a very small portable size to those which require a separate room for installment and operation. The most commonly used is in the form of a "Dental X-ray unit" (Fig. 402) which located in the operating room is quickly available for the many demands which present day operations make imperative. While a dark room for the development of the X-ray films and plates is a very desirable adjunct to the office, the results may be obtained by the use of special developing cabinet. (Fig. 400, 401.)

The prosthetic laboratory should be within easy communication, but sufficiently removed from the other rooms to insure freedom from odors or noise reaching them. The description of the fitting of the laboratory is best delegated to works upon prosthetic dentistry.

If extraction forms a part of one's practice, a separate room should be provided for the specific purpose, fitted with the necessary chair, anesthetizing apparatus, cabinet, running water, etc.

RECEPTION OF PATIENTS

The manner of the reception of patients should be given careful consideration. The beginner will naturally commence his operations upon

M..

Address { Home ....
Business ....

Telephone { Home ....
Business ....

Reference ....

REMARKS.

....
....
....
....

Fig. 404.

such of his personal friends and acquaintances as seek his care. These in turn will be the means of sending others. The referring of a new patient,

by either friend or fellow practitioner, should always be acknowledged by note or in person.

When a practice has assumed normal proportions, a systematic record should be at hand to give the necessary data regarding each patient. To obtain such record the following method is advised: A new patient making his first visit is confronted with the following card (Fig. 404) which is filled out and filed in a cabinet (or drawer) and the reference given looked up; if satisfactory, much is gained in establishing cordial relations and the possibility of financial loss greatly diminished.

PERSONAL TREATMENT OF PATIENTS

The success of an operator is commensurate with his ability to "measure up" to the needs of those who require his services. No two patients can be treated alike; some are particularly nervous and should be given every assistance in their endeavor to overcome the condition. Help such to think of something other than the operation itself. Some time is well spent if used for the patient's good in this manner. Allow conversation to pass to a congenial channel, while progressing as rapidly as possible with the operation required. Much more can be done upon such cases with this procedure than could otherwise be accomplished. In fact, many patients will voluntarily offer to pay for extra time and labor thus spent in their behalf rather than endure the stress of a strenuous sitting.

On the other hand there are those who can endure any operation with little or no ill effect. Upon such the operator may proceed with no hesitation. Patients appreciate the care that is paid their individual peculiarities. There is no surer way to build up a practice than by such treatment as this, added to sincere, loyal service rendered and honest operations performed.

Children should receive the same consideration as their elders. Dr. Ottolengui, when questioned regarding his apparent success with children, expressed his belief that it was due to the fact that he treated them like "grown folks;" and, he added, the longer he practice the more he treated "grown folks" like children.

A little one may come to an operator for the first time with no previous knowledge of or dread concerning a pending operation. The utmost care should be exercised to prolong that condition of mind. Let a child once acquire a dread of a dental visit and a serious handicap is placed upon the effective service of the operator—a handicap which years of diplomacy may be necessary to overcome. If a child receives other than the most considerate care in the hands of an operator he has only himself to blame

for much unnecessary trouble. It has been most wisely said, "Take heed lest ye offend one of the least of these little ones." The young practitioner should consider that these are the ones who, if treated carefully and conscientiously, are to be the mainstay of his later practice and the ones whose operations he will look back upon in after years as his long standing successes.

ASSISTANTS

The subject of assistants has already been referred to; it seems wise, however, to lay some stress upon the advantage of the presence of some one—preferably a lady assistant—at the chair to render aid to the operator, care for the personal comfort of the patient and assist in innumerable ways in furthering an operation, thus saving time for both operator and patient.

Great aid is found in having such an assistant trained to select and handle instruments; provide treatments; prepare cement and amalgam fillings ready for insertion and assist in the operation of filling; understand the mechanism and control of the electric switch-board and attend to it if desired during an operation; prepare gold for filling purposes and assist in carrying it to the cavity; manipulate impression material preparatory to taking impressions; care for the cleaning and sterilizing of all instruments after an operation and note their return to their proper places. To these duties some add the making of inlays and kindred matters.

UTILIZATION OF TIME

The important assets of a dental practitioner are his *skill*—the result of his training and education—and *time*. To misuse either is to fail to attain the highest possible success.

Primarily, a beginner should endeavor to fill his time full. Arrange for definite hours of work and fill those hours; if not occupied with the immediate care of patients—for all will not be blessed with an abundance at once—consume the time either in experimental work upon lines already laid down in college or in study. As time goes by less and less opportunity will present itself to the busy practitioner and he looks back with regret upon time wasted when it might have been used to advantage. Do not be afraid to accept work even if the most moderate compensation is to accrue. Consider early practice in the light of valuable post-graduate experience and count the cost of apparent loss as chargeable to a personal "profit and loss" account. Be ready to make sacrifices for the good of others at all times, but especially now when time is not of such value as it will be later in practice. Many young practitioners accept infirmary and

dispensary positions with little or no monetary compensation and reap golden harvests of experience.

As practice increases time becomes more valuable and justly should be devoted to the personal clientele. Here comes an important consideration; many men seem to feel that their own time is the only thing to be

TELEPHONE..

M..

HAS AN APPOINTMENT WITH

....D. D. S.,

....AVENUE,

....

....

....

A CHARGE WILL BE MADE FOR ALL APPOINTMENTS BROKEN

WITHOUT TWENTY-FOUR HOURS' NOTICE.

M...

has an appointment...

....................................*the*....................*at*..

with ....*D. D. S.*

....*Avenue,*

IF UNABLE TO KEEP THIS APPOINTMENT PLEASE GIVE DUE NOTICE,

OTHERWISE CHARGE WILL BE MADE FOR THE SAME.

CONSULTATION HOURS FROM 4 TO 5 P.M.

FIG. 405.—(Appointment Cards.)

considered. Just as much importance should be attached to the time of the patient. As is indicated by the appointment card (Fig. 405), a patient is given an appointment for a definite day and hour; that hour belongs to that patient and should be as nearly as possible fulfilled to the minute. Habit can accomplish much in preparing for the proper arrangement of a day's work so that the various appointments may not conflict or overlap too

greatly. Nothing but a serious complication is a sufficient excuse for the consuming of one patient's hour for the benefit of another. It is just that a broken appointment, *i.e.*, one broken without due notice, should be charged for and it is equally just that a patient should receive full value in time for an appointment set and without delay. There are occasions when a patient's time may be of vastly greater commercial value than the operator's and if the rule of charging for "broken appointments" were reversed and the dentist were the one to be charged for unfulfilled obligations, the full force of the justice of this statement would be acknowledged.

EXAMINATION RECORDS

Too great value cannot be placed upon accurate records of all operations performed. Three forms of examination cards are here given, any one of which is ample for the requirement, and a choice of which is a matter of individual taste. (Fig. 406, Nos. 1, 2 and 3.)

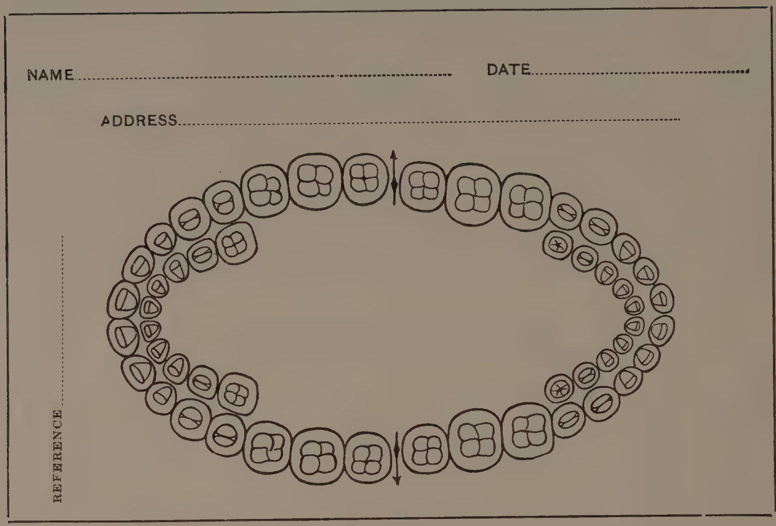
When a patient first presents himself, in addition to the reference card already mentioned (Fig. 404), the results of the oral examination should be recorded and filed in proper case or cabinet in alphabetical order. This card may be kept separate from record cards of operations performed, or used as both examination and record card till filled, when a second card for the same patient, marked No. 2 on its upper left hand corner, may be substituted and the old card filed away.

Some practitioners dispose of old cards, but it is a wise practice to file all such away so that at any future time a consecutive history of every operation performed may be at hand. Many times these records are invaluable for legal purposes if any question or statement should arise demanding enlightenment or verification. Also, much value has been given them as means of identification of those who have lost their lives by accident.

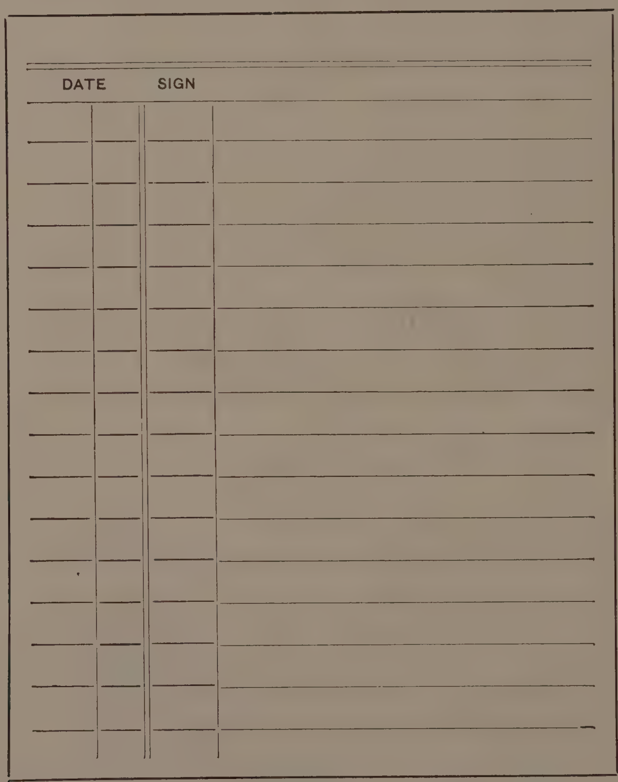
DAILY RECORDS

As each operation is performed it should be marked upon the diagram and either by sign or number its character recorded upon that part of the chart assigned for such record. This should be done immediately to avoid error. Some practitioners make no further daily record than this; others prefer to add a record upon a separate daily record card (Fig. 408) showing all operations done during the day, which, when transferred to the proper accounts, may be filed away among a collection which may be referred to at any time for information regarding any particular day's transactions. Still others make a record in a daily record book. As each patient's operation is completed the time consumed

Examination Blank No. 1.



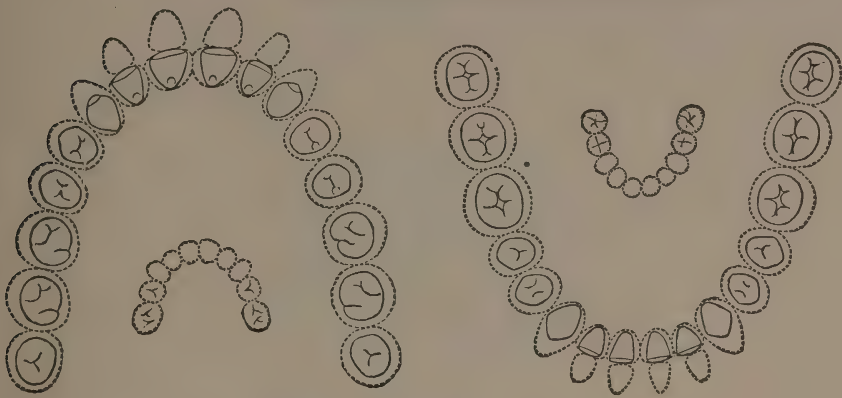
(Front)



(Back)

Fig. 406.—(One of Three Examination Blank Forms.)

Examination Blank .N 2.



SUGGESTED BY S. H. GUILFORD, A. M., D. D. S.,

Examination Blank No. 3.

Date 190

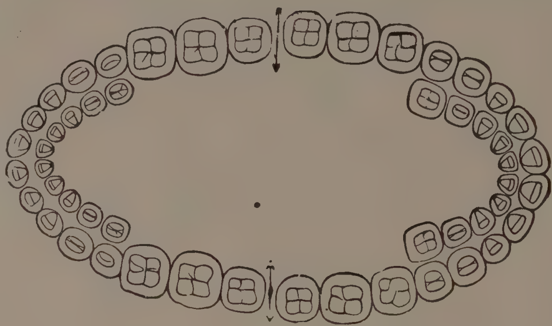
Examination of M ....

teeth.

Remarks: ....

FIG. 407.—(Nos. 2 and 3 of Examination Blank Forms.)

CARD SYSTEMS



190 ....

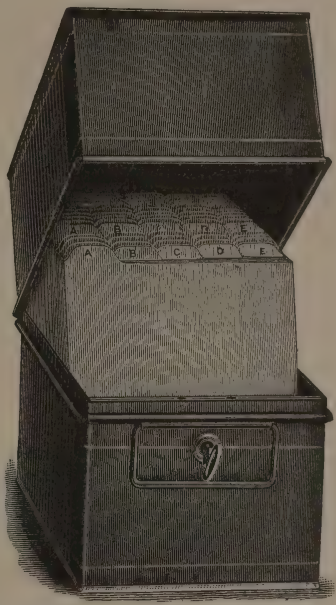
Month, ...

Day, ...

NAME.	REMARKS.	CHARGES.	

Fig. 408.

is marked, operations indicated, etc. The advantage of the daily record book is that it gives an opportunity to insert every important event of the day, as, for instance, the visit of a patient to pay a bill or to leave an important message which should receive prompt attention at the end



Reduced Illustration of Guilford's Tin Case Outfit.
Actual size, 5 inches wide, 8½ inches long, 7½ inches high.

The accompanying method is an adaptation of the Card Index System to the use of the dentist. It takes the place of the Ledger, Cash-book and Bill-book all of these accounts being kept on separate cards in the same box under suitable headings.

FIG. 409.

of the day's duties. A portion of a page of such a record may include items as follows:

MONDAY, DECEMBER 17, 1906

8:30. John Jones.
Root treated | 2
1 Amalgam | 8 D
9:25. William Brown.
Bill paid $18.00.
9:30. Mrs. N. Smith.
1 Gold | 4 M-O.
(Send appoint. to
Miss Smith for Jan'y.)

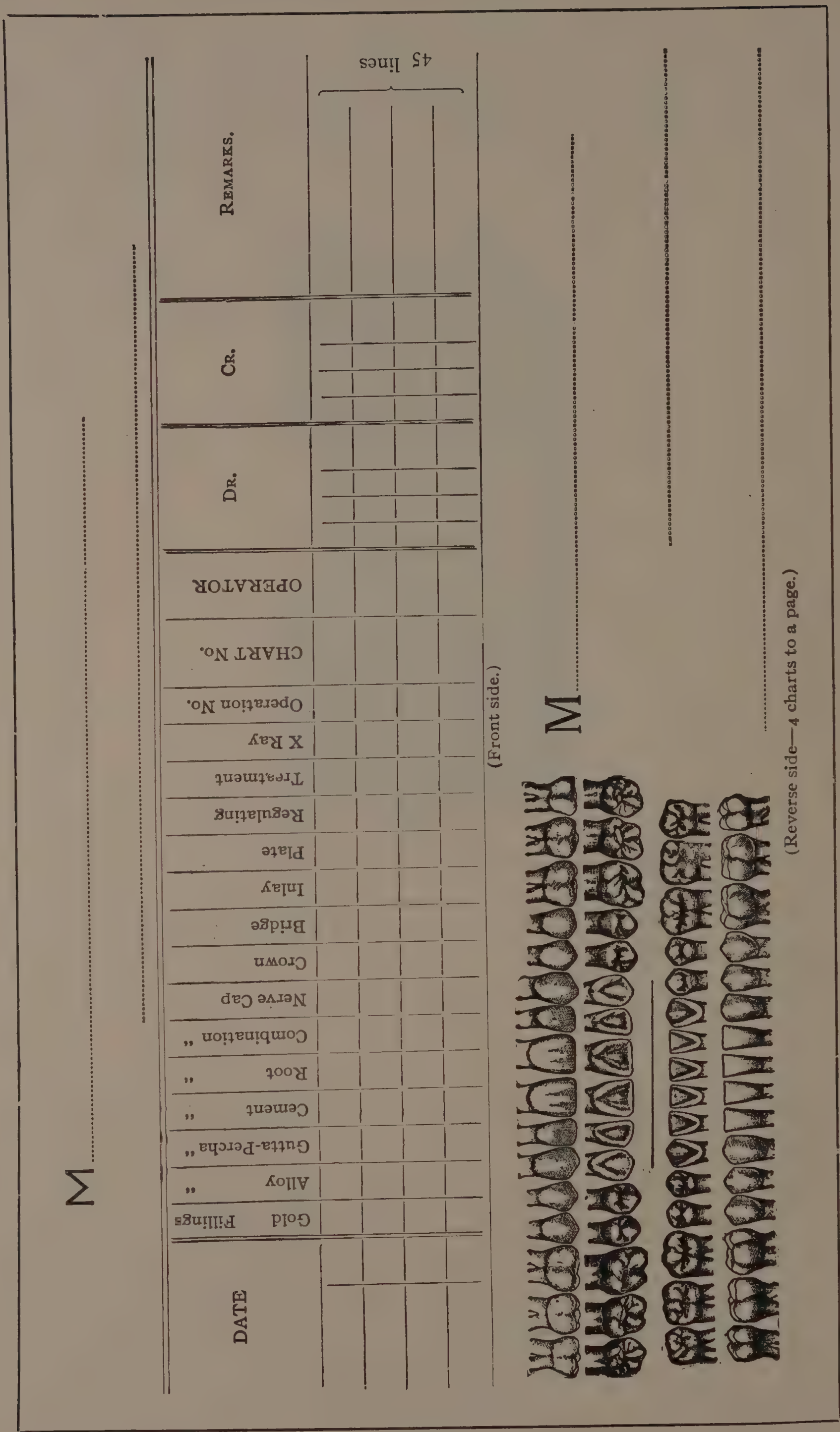

M
DATE
Gold Fillings
Alloy "
Gutta-Percha "
Cement "
Root "
Combination "
Nerve Cap
Crown
Bridge
Inlay
Plate
Regulating
Treatment
X Ray
Operation No.
CHART No.
OPERATOR
DR.
CR.
REMARKS.
45 lines
(Front side.)
M
(Reverse side—4 charts to a page.)

FIG. 410.

Reference to various teeth should be made by numbers as indicated:

Permanent Upper

8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8

Lower

Temporary Upper

V	IV	III	II	I	I	II	III	IV	V
V	IV	III	II	I	I	II	III	IV	V

Lower

The various surfaces should be affixed.

All these record cards demand system and today little in the way of business method is not applicable to systematic arrangement. That systems are time savers is an undoubted fact. Such being the case, there is no excuse for their non-adoption. There are many laudable systems which may be found on sale at the various dental depots. One system, arranged by Dr. Guilford, of Philadelphia (Fig. 409), comprises a full set of cards, with guide cards and places arranged for the tabulation of all necessary data including charges, etc., thus doing away with all necessity of other book-keeping. This feature appeals to many while others prefer to have no record of charges upon cards.

The cards in these systems are usually divided into three sections each arranged alphabetically; the first division is for cards of patients whose operations are incomplete; second, for those whose operations have been completed but whose bills are not paid; the third for completed cases whose accounts are closed.

The advantage of having an added record in book form is that it gives a duplicate in case a card should be mislaid or destroyed, and also affords an opportunity to have at a glance all data desired for long periods. The following (Fig. 410) is a page from a loose leaf ledger which is an admirable example of what concise records may be. This page has 45 lines upon it, but the number may be made whatever is desired. If books are kept no charges need be displayed upon the cards themselves.

Another excellent system is that of having a set of envelopes to be filed alphabetically. These are intended as a depository for inlays, crowns or dentures ready for insertion or for whatever is of any personal interest or value connected with a patient, such as X-ray negatives, anomalous teeth, etc. Whatever is deposited within the envelope is marked upon the face under the patient's name for immediate reference. In this day, when so many are using the impression method of preparing both gold and porcelain inlays, this system commends itself as the resultant dies may be filed

M..

THE CUSTOMARY INTERVAL HAVING ELAPSED SINCE YOUR LAST CALL, I APPOINT

....

FOR AN EXAMINATION.

SHOULD THIS TIME PROVE INCONVENIENT TO YOU, KINDLY INFORM ME AND I WILL MAKE ANOTHER APPOINTMENT.

VERY TRULY YOURS,

....D. D. S.

.............................AVENUE

TELEPHONE.............................

(THIS APPOINTMENT IS FOR EXAMINATION ONLY.)

....190

M..

In compliance with your request, we beg to inform you that we have appointed.................. the..........................at...............o'clock to examine your teeth, ...months having elapsed since your last call. Should this prove inconvenient kindly advise us at once, that we may arrange another date.

Respectfully yours,

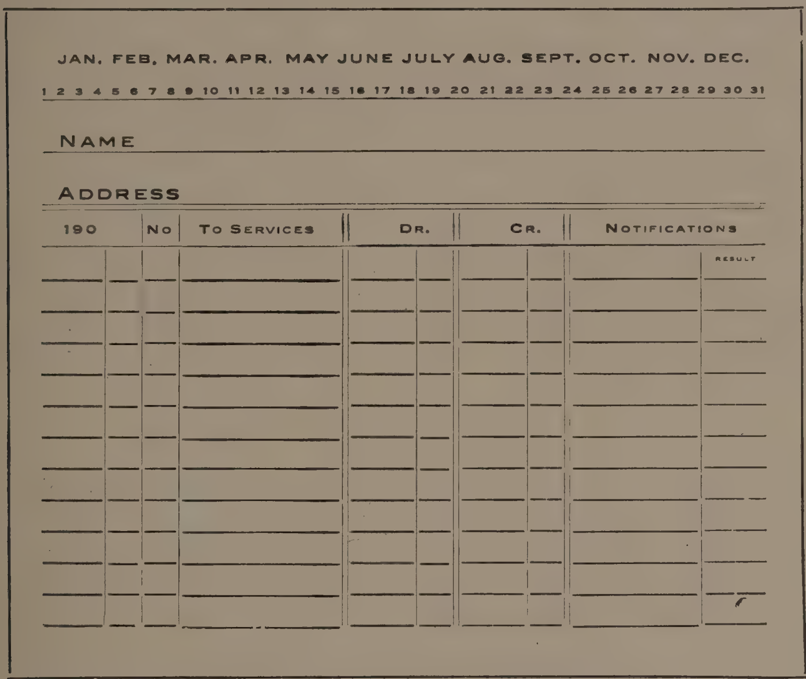
.......................*Avenue,* *Dr.*..

FIG. 411.—(Notification Cards.)

away in their proper envelopes, and duplicate inlays may be made at a moment's notice, if required.

NOTIFICATION OF PATIENTS

The gratifying increase in prophylactic measures in dental practice today makes it essential that a distinct supervision of the patient's visits should be maintained by the attending dentist. To regulate these


JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

NAME

ADDRESS

190	No	To Services	Dr.	Cr.	Notifications	Result

Fig. 412.—(Chart of Teeth upon Reverse Side.)

visits, some system is necessary as some patients require more frequent examinations than others. There are some practitioners who expect a visit from their patients at least once a month. The results which follow such a course are wonderfully satisfactory in preserving the patient's teeth. Others extend the time to two, three and six months. Few patients, if any, should be allowed to go without examination for a longer period. Several plans are in vogue to accomplish the supervision sought. A simple one is to have one card for each month in the year on file. When a patient's operations are complete and he is dismissed his name is placed upon the month card—one, two or more months in advance—with the date and time of day preferred. Just prior to the first of every month the next month's card is taken out and the notification cards transmitted. (Fig. 411.)

This month's card then becomes "ancient history" and the next month's card takes its place in the front rank to be taken up in its proper time. The old card, however, may be kept and the result of the notification noted, *i.e.*, if the appointment is kept or not, and, if not, the reason given for its rejection or postponement—opportunity being then given for a change of date with no break in the continuity of procedure by oversight.

A very excellent plan has been devised by Dr. W. A. Cotton, of New York, to meet these several card requirements upon the patient's original record card (Fig. 412).

This gives the months upon the upper margin with the dates just underneath. Two little clips are used, one solid and colored red to be placed upon the month desired for the next appointment; the other a cut out clip to show the day. To this might be added a third to indicate a special hour if desired.

That the practice of continuous appointments is a growing one is certain and to the intelligent public it is a great blessing, as it provides constant care of their dental welfare with no personal obligation to remember the proper periods between visits and an assurance that, barring accidents, their teeth will be kept in the best condition and in the most economical manner.

FEES

The subject of fees is a difficult one to discuss from any standpoint and especially so in dealing, as is the intention of this chapter, with undergraduates about to start upon their professional career. I stated at the opening of this chapter that one need not expect to grow wealthy practising dentistry. Wealth, however, is a flexible term and I must leave that to each individual. Charges for services should be computed upon the basis of several considerations; first, "How much is the operation as I have performed it worth, considering all things?" This last phrase covers much ground. The beginner does not expect to value his time as highly as that of the man who has practiced for years, nor are his services as valuable in result—except in rare cases— as those of the more experienced. Hence the fee for the same operation by one man need not necessarily be the same as that of his fellow practitioner.

Environment has a bearing upon fees; a man in a small village with little expense can afford to charge less than his confrere in costly surroundings with proportionate increased expenses of a city practice.

Another very important consideration is this: "Can this patient afford to pay my usual fee?" Many a time in making up the estimate of the value of an operation will this question obtrude itself and it must be met conscientiously. There should be no such thing as a fixed and unalterable

price for an operation. There are some who will need your care; give it cheerfully, and, whether or not the exact remuneration in dollars and cents results, the satisfaction of duty performed will always remain with you and the successful building up of a practice will be assured.

The basis of calculation of fees differs with different men. Some charge for each filling, denture, etc., rating the fee according to the size and character of the operation; others charge a certain fee for an hour's services, not considering the character of the operation performed. There are faults in each system, and the only satisfactory one seems to be in a combination of both.

That some operations, while taking a short time, may be exceedingly arduous upon the operator yet extremely valuable to the patient is an accepted fact; and the question arises should such an operation be charged for upon the same basis as one which, while taking considerable time, is neither a severe task for the operator, nor of great value *per se* to the patient.

Then, too, some operators are rapid in their operations and accomplish much in an hour of thoroughly satisfactory work. A confrere, with the same conscientious care and results takes twice as long. Should they receive the same compensation?

STATIONERY, BILLS, ETC.

It has been said that "we are judged by the company we keep" and a professional man is often rated by the stationery he uses. This should be as neat and unobtrusive as possible. Anything beyond one's degree and address is unnecessary upon professional cards or note-heads. The addition of "Dental Surgeon" or "Surgeon Dentist," etc., is needless except as a covert attempt to enhance by the term the degree which should need no such enhancement to sustain its professional dignity.

The rendering of bills for professional services may be accomplished in several ways to advantage. Upon the bottom of the bill a clause is placed which reads "Bills rendered upon completion of operations" (Fig. 413).

This may be a rule from which deviations are permissible. Many prefer to render statements for all work accomplished during a month; others at the end of two months; still others at the expiration of six months, in which case June 1st and December 1st are the dates preferred.

Questions arise from time to time regarding the best manner of rendering a bill; should such be itemized or not? This must be left to the practitioner to decide for himself.

Some prefer to enclose with the bill, for the exact information of the patient, a chart showing just what has been done—practically a duplicate of the record card—indicating the time spent upon and the charge for each

__________ Avenue,

__________ 190

M

To __________ D. D. S., Dr.

For professional services:

Received payment.

Bills rendered at the completion of operation

Fig. 413.

operation; others enclose the record card but omit the individual item charges; others omit all record cards (unless requested for them) feeling certain that their patients have all confidence in their honest intentions in rendering statements.

When bills have been prepared an accurate alphabetically arranged list should be made with the amounts affixed. As returns are received the name and amount should be erased from the list and the credit recorded in its proper place. When subsequent bills are required to be rendered, delinquents are thus easily traced and duplicate statements marked as such. Failure to respond by a client places one in the position where he may require either the services of a collector or, *in extremis*, a lawyer to enforce a settlement.

When all is said the great secret of the management of a successful office practice lies in the spirit of the well-known lines:

> "To thine own self be true,
> And it must follow, as the night the day,
> Thou canst not then be false to any man."

Exact of yourself the highest standards of attainment, ideals and culture. Strive to live up to these standards and the result will be in other hands than yours.

CHAPTER XXXII

THE APPLICATION OF THE ROENTGEN RAY TO DENTISTRY

BY C. EDMUND KELLS, D. D. S.

As numerous text books, that are devoted exclusively to dental X-ray work, have been written, it is evident that it is no light task to curtail the information upon this subject, which should be laid before the student, into one single chapter. However, in this limited space, every endeavor will be made to acquaint the student with such fundamental information as he will require in order to be able to *begin* such work, while, at the best, he will find he must work his own way out of the difficulties with which he meets, no matter how many text books he may have read. It becomes simply a case of perseverance, as it is, in fact, in every branch of dentistry.

History.—In 1879 Dr. Wm. Crookes, an eminent English scientist, gave to the public the result of his investigations of the properties of matter in high vacua, which had been made in what was, and still is, called the Crookes' tube (Fig. 414), from which the air was exhausted to the one millionth of an atmosphere.

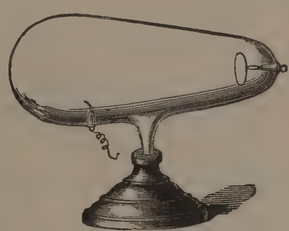


FIG. 414.—The original Crookes' tube.

For seventeen years these tubes were found in laboratories throughout the world, and scientist and student, alike, were charmed with the study of the *cathode* ray within the tube, but their usefulness extended no further.

The X-ray.—In 1895 Professor Wilhelm Roentgen, of Wurzburg, sent a thrill of surprise and incredulity throughout the civilized world when he announced that however interesting to the student were the features produced within the tube by the cathode ray, of vastly more wonder and importance were the effects produced beyond the confines of its glass walls.

Professor Roentgen, in his modesty, called these "*X-rays*," (from X, the unknown quantity in algebra) but an appreciative world has given them the name "Roentgen Ray," the term "X-ray," however, being used for brevity.

While the X-rays were found to possess the power to penetrate substances that had hitherto been opaque to any rays known to science, they differ from ordinary light rays in that they pass through all substances in straight lines, so far it having been found impossible to either deflect reflect, or refract them.

Their great value, however, to the world in general, depends upon their power to penetrate the various anatomical elements of the human body in different degrees, and their action, similar to that of light rays, upon the ordinary photographic plate or film.

Early Days.—In the early days, dentists were rather slow in adopting the ray to their daily practice, and possibly there were reasons for that; but today the ray is acknowledged to be one of the greatest aids to the practicing dentist, and hundreds of dentists have their own machines and use them constantly.

It is safe to say that *modern high class* dentistry depends entirely upon the use of the X-ray for its existence, and without the ray it could not be practiced.

Nomenclature.—The nomenclature of any art or science, which is adopted by the national association of men who practice that *individual* art or science, should usually be accepted as final. The following is the official nomenclature adopted by the American Roentgen Ray Society and also by the A. M. A.

Roentgen ray. A ray discovered and described by Wilhelm Konrad Roentgen.

Roentgen. To be pronounced rent-gen.

Roentgenology. The study and practice of the Roentgen ray as applied to medical science.

Roentgenologist. One skilled in roentgenology.

Roentgenogram. The shadow picture produced by the Roentgen ray on a sensitized plate or film.

Roentgenoscope. An apparatus for examination with the fluorescent screen excited by the Roentgen ray.

Roentgenograph (verb). To make a roentgenogram.

Roentgenography. The art of making roentgenograms.

Roentgenize. To apply the Roentgen ray.

Roentgenism. Untoward effect of the Roentgen ray.

Roentgen diagnosis. Roentgen therapy; Roentgen dermatitis. These terms are self-explanatory.

In addition to this Roentgen nomenclature, the following terms are in general use.

Radiogram.

Radiograph.

Skiagraph, meaning the Roentgenogram.

The following words were suggested by Dr. R. Ottolengui and are in general use to-day.

Radioparent. Offering no resistance to the passage of the ray.

Radiolucent. Offering slight resistance to the passage of the ray.

Radiopaque. Impervious to the ray.

Dr. Howard Raper coined the following words, which are also considered standard now.

Radiodontist. One who specializes in dental X-ray work.

Radiodontia. The application of the X-ray to dental practice.

While, therefore, the Roentgen nomenclature, adopted by the American Roentgen Ray Society, and also adopted by the A. M. A., must be considered as that which *should* be used by all writers, the facts are that those terrible words prove so unpronounceable to so many speakers, that it is no wonder that most dentists and physicians alike are prone to use some of the less scientific, but more popular terms.

Therefore it is that the word Roentgenogram is seldom used, and one hears the words radiogram, radiograph and skiagraph used instead. And so, while a few of the most scientific men use the Roentgen terms, the *rest of us* do not, and, therefore, the popular and more euphonious terms will be used throughout this chapter.

There being no authority for using any one of these *popular* terms, each operator can select the one which he prefers, and he need *fear no criticism.* Having used the word *skiagraph* constantly and exclusively for twenty-six years past, it will now be used, though I must confess the word *radiograph* is probably the more popular term to-day.*

Dangers of the Ray to the Operator.—The earliest X-ray operators soon learned, by sad experience, that the rays, harmless as they first appeared to be, could produce the most serious burns upon the patients who were directly exposed to them for a considerable length of time.

Naturally, these operators could not then be aware of the fact that repeated short exposures of themselves would gradually produce deleterious effects, and not until after frequent exposures, with first one and then another of the pioneer operators manifesting its symptoms, was this discovered.

While all of the early operators used unprotected tubes and thus were directly exposed to the rays, no one now needlessly exposes himself to the effect of the ray.

X-ray Dermatitis.—While many a man has given up his life as a result of X-ray burns, which first manifested themselves as a slight

* At the 1922 Meeting of the American Dental Association, the Committee on Nomenclature brought in a report advocating the word "radiogram" (n) for the film, and "radiograph" (v) for the process of making the film. *Editor.*

dermatitis upon his hands, there is absolutely no danger of this to-day, if the operator will be sure to use the most ordinary precautions.

One thing he should never do—and this is, *hold the film in the mouth of the patient.*

Protective Measures.—Tubes are now encased in lead glass protectors—lead glass being more or less impervious (according to its thickness) to the ray. Besides this, operators stand behind sheet-lead screens (Fig. 415) or else in lead-lined rooms, while the tubes are in operation.

It is not possible to be too careful if one uses the machine constantly. However, if one uses the ray but occasionally, as would be the case in ordinary dental practice, the modern Coolidge tube is sufficiently protected in itself to cause no injury.

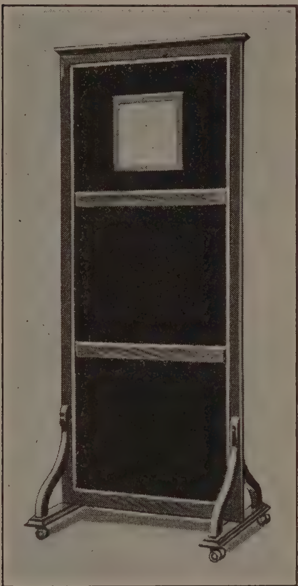


Fig. 415.

Danger to the Patient.—With a small Coolidge tube of the radiator type, which is made of lead-glass and provided with a window for the exit of the rays, there is no need of any protective screen or filter being placed between the tube and the patient; but with the Coolidge Universal tube, or with gas tubes, it is safe to interpose a thin sheet of aluminum between the tube and the patient, which acts as a filter by allowing the hard rays to proceed, while the soft rays, which are the harmful ones, are intercepted.

Alopecia.—In the early days, the loss of the hair (Alopecia) was not an infrequent result of rather long or frequent exposures, but this effect can hardly be produced with any modern machine and its short exposures. This, however, was not a very serious result, as the hair always grew out again and was usually quite curly.

The High Tension Current.—While it may thus be safely said that there is, to-day, no danger, either to the patient or operator, from the ray itself, one must not forget that the high tension wire, leading from the generator to the tube, carries a death dealing current, and if, by any chance, any one should come in contact with this wire, he would probably be killed. At least one death, if not others, has been caused by such an accident; so no one can be too careful in handling an X-ray machine.

Sterility.—In the early days, it was soon noticed that babies no longer came to the homes of the men who had become X-ray operators, and before long it became a well established fact that constant exposure to the ray

resulted in sterilizing the male. Whether or not the same result is produced in women is not so assured.

In this connection, it is interesting to note that when visiting large medical or surgical institutions, one may find an unmarried woman, of, say, fifty, as the chief operator, and she will stand behind a lead screen, or in a lead lined room, when running the tube. Another evidence of "while there's life, there's hope."

Practical Value of the Ray.—The value of the X-ray in dentistry and surgery depends entirely upon two of its properties—the one, its effect upon the emulsion of the photographic plate; and the other, its production of the phenomenon of fluorescence upon certain substances.

The Skiagraph.—While, for ordinary purposes, a skiagraph may be looked upon as a shadow picture, or a photograph of the invisible, yet, to be exact, it is not a photograph at all. Rather is it a series of effects produced upon the emulsion of the film by the varied resistances offered to the passage of the rays by the objects lying between the film and the source of the rays.

Apparatus in General.—In a chapter of this character, space being limited, it is impossible to describe all of the various kinds of X-ray machines available for dental X-ray work, or the various methods pursued by different operators, nor would this be desirable even if space were at hand. Neither is this the place to discuss the elementary principles which govern the working of the machines.

The apparatus which I now use will be described, and the details of the taking of dental skiagraphs, by methods now followed, will be covered as clearly, and yet as concisely, as possible.

It is assumed that the ordinary student must have absorbed, by his constant contact with and observation of electrical apparatus in use on all sides to-day, a certain amount of kindergarten knowledge concerning electricity in general. He must know that the "direct" and "alternating" currents are those commercially available to the general consumer of light and power, and that, as a rule, apparatus which was designed to be operated by the one current is not suitable to be operated by the other. Now and then one finds an exception to this rule, and a motor which can be operated by either current.

He should know that storage and primary batteries are available for a limited amount of power where commercial currents cannot be had, and that there are the Rhumkorff and Tesla coils, and also what are called transformers—all available for X-ray work—and many other points about electricity must have come to his knowledge.

Wonderful advances have been made in the past twenty-five years, and so, in order to keep abreast of the times, the student must have his name on

the mailing list of the principal manufacturers of X-ray apparatus, and also upon that of the leading makers of films, and read their catalogues and other fresh literature with care.

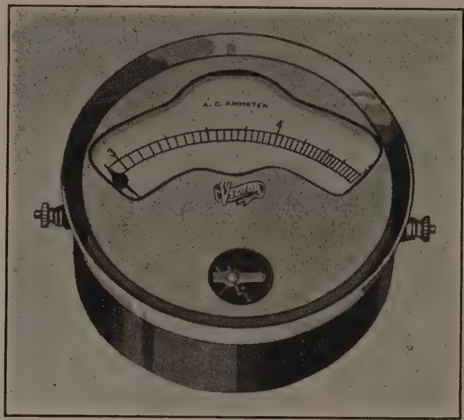
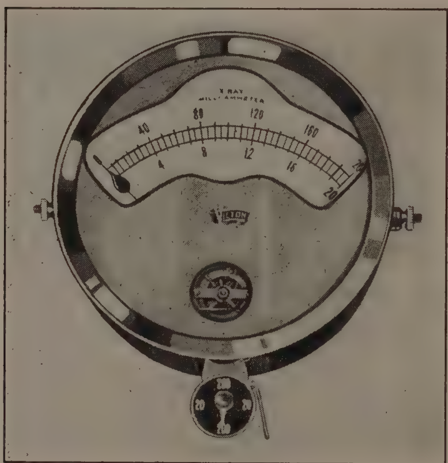


FIG. 416.

Ammeter.—The ampere meter, always called *ammeter*, as shown in Fig. 416, registers, in amperes, the quantity of current that is passing through the line.



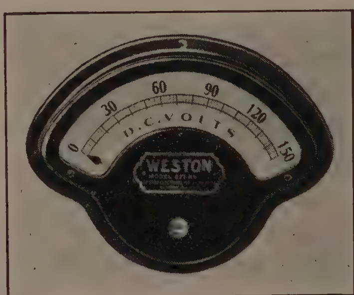


FIG. 417.

FIG. 418.

Milliammeter.—This registers the milliamperes which the X-ray tube is taking. (Fig. 417.)

Volt Meter.—This meter registers the voltage of the current used. (Fig. 418.)

Rheostat.—The rheostat is an appliance for regulating the quantity (amperes) of current which is passing through the line.

Usually it consists of an iron box containing a series of resistance wires, embedded in enamel, which insulates them and renders them fireproof.

Upon the face of the box, which is made of slate, is a pivoted lever, the free end of which slides successively over a series of contact points, each of which cuts in or out, as the case may be, a certain amount of the resistance wires, thus allowing more or less current to flow through the line. A standard form of rheostat is shown in Fig. 419.

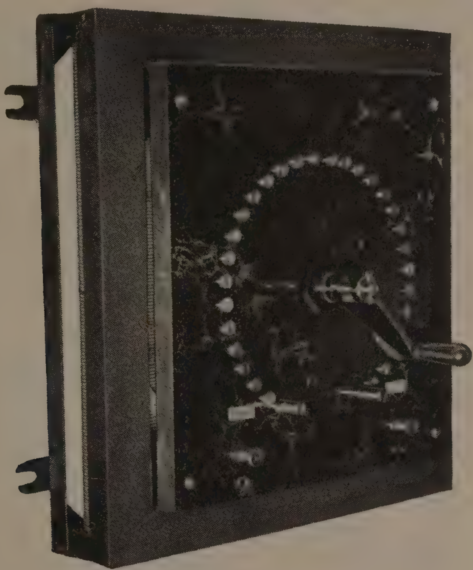


FIG. 419.

The Fluoroscope (Roentgenoscope).—Many substances possess the peculiar property of becoming fluorescent under the influence of the X-ray. The advantage of this is taken in the construction of the ordinary fluoroscope. (Fig. 420.)

The best are constructed with a platinum-barium-cyanide screen, backed up with a sheet of lead glass to protect the eyes and face, and the handle is guarded by a heavy lead sheet to protect the hands.

Dental Fluoroscope.—Attempts were naturally made, by the early dental operators, to make a dental fluoroscope. A small fluorescent screen was placed at the end of a tube, and mirrors were so placed as to render the shadow of a tooth visible. The only drawback to this scheme is that it won't work.

The ordinary fluoroscope is of no value to the dental operator except for exhibition purposes.

The X-ray Plant of To-day.—There are on the market to-day two classes of X-ray apparatus—the one, the larger and more powerful machine, consisting of several different parts, and the other, the small and compact "bedside" or "dental units," as they are called, which, while they will not do heavy or rapid work, are sufficient for the purpose intended.

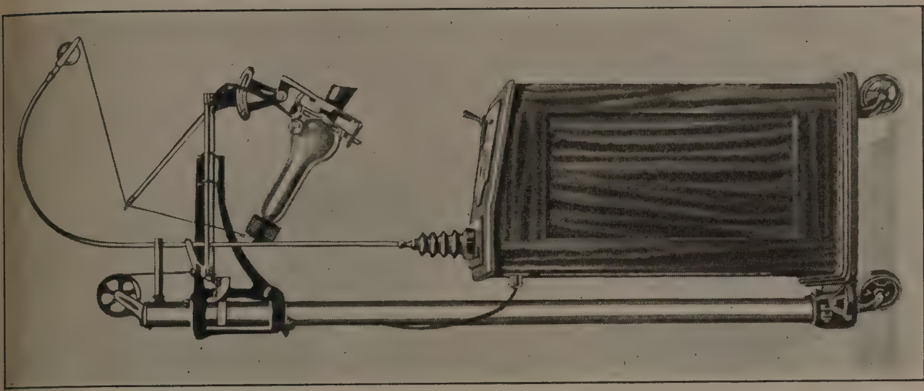
Selecting a Machine.—My advice about selecting a machine is this: If the salesman or his operator cannot put a subject in the chair and take for him several skiagraphs (which he develops) which show the

FIG. 420.

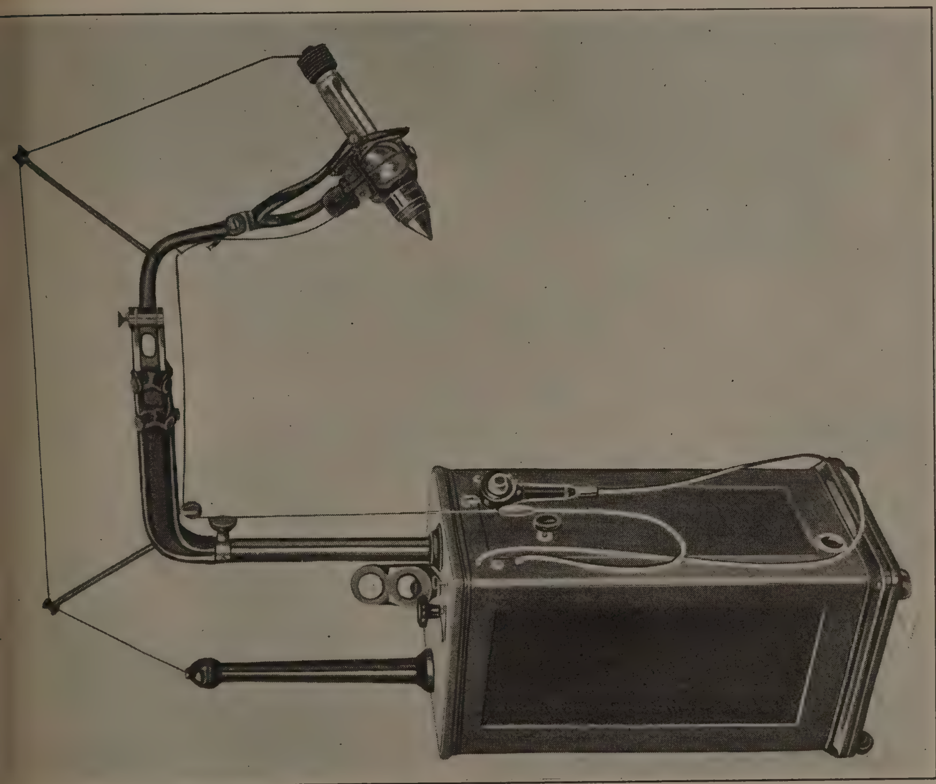
necessary details for a diagnosis—that is, the *peridental membrane* and the lamina dura—then that is no machine for you, because if the trained operator cannot do this, what hope has an untrained one? The fault must be in the machine.

Again, when purchasing a machine, look for the service that goes with it. A machine and no service can hardly prove satisfactory. That's one good feature about the Victor machine—I must say good service has gone with it as far as I have been concerned.

In order to make a sale, some salesmen of X-ray machines are sometimes a little careless in what they say. One, in particular, "broke into print" with the statement that the "*office girl*" of *any dentist* could



Victor Dental Unit



Ritter Dental Unit

FIG. 421.

pay all his overhead expenses by taking dental skiagraphs. That, of course, is a most outrageous statement. That means that that individual salesman thinks that dentists are dishonest enough to allow their office girls to take skiagraphs right along, whether they are necessary or not, just to pay their office expenses. Can you think of a statement that could be more damaging to the character of the men in the dental profession, or that could reflect more upon the integrity of the salesmen?

Dental X-ray machines should be installed *only* because good work cannot be done without them, and for no other reason. The fact that they are a source of income—moderate income honestly earned—should be a secondary consideration.

The Dental Unit.—In Fig. 421 are shown two of the popular "dental units."

There are a number of these units put out by various manufacturers, all differing somewhat in appearance and details, but they are all built upon practically the same design.

Personally, as I have had no experience with such units, I can not express an opinion upon their value, but I assume that they are all satisfactory to those who use them. A larger and more powerful machine is preferred, and I am willing to put up with its minor inconveniences for the sake of obtaining what are considered its advantages.

The disadvantages of this outfit are that it requires a good deal of space for the placing of its various component parts, practically requiring a room of its own, and it is also more expensive than any dental unit.

The Victor Universal Junior.—Here, in Fig. 422 is shown the apparatus now used.

The X-ray Chair.—While an ordinary dental chair, for seating the patient, can be used with this apparatus, it is about as unsatisfactory for the purpose as it possibly could be. There being no chair to be found that suited my requirements, the one shown in Fig. 423 was designed and constructed.

There are two salient features in this chair. The one, that the seat and back revolve upon the pedestal; and the other, that the seat is so placed upon the pivotal point that when the patient is seated, a straight line drawn down through the centre of the head passes through the pivot of the chair.

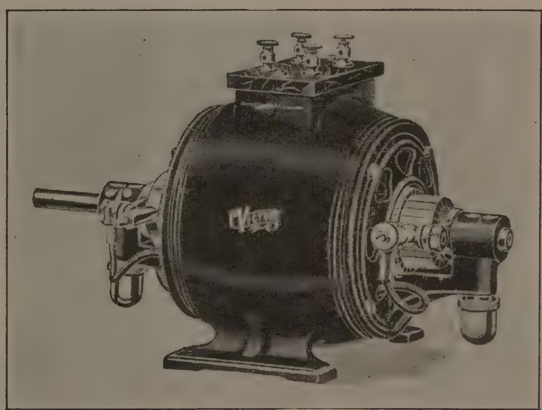
This is *the* feature of the chair. The patient is seated perfectly upright in the chair, head-rest adjusted so that the occlusal planes of the upper teeth are horizontal. The tube and patient are positioned for the taking of a skiagraph of the lower third molar.

It is then possible, by revolving the chair, and tilting the head slightly when necessary, to bring every one of the lower teeth in line for a picture

Victor Universal

Coolidge Transformer

Rheostat



Rotary Converter

FIG. 422.

without changing the horizontal adjustment of the tube, or moving the tube stand, or moving the base of the chair.

The same process holds good for the upper jaw. The tube can be set at the proper angle for the third molar, and then again, by revolving the chair and tilting the head slightly when necessary, every tooth can be skiagraphed from the proper angle without any adjustment of the

Fig. 423.

tube; all of which makes for the rapidity with which a full set of pictures may be taken.

Tube Stand.—In Fig. 424 is seen the tube stand now used. It is made by the Kelley-Koett Mfg. Co. of Covington, Ky., has a stereoscopic shift, and is very satisfactory.

However, I do not use the cone shown, as I prefer the *dental pointer* as shown in Fig. 425. This is a very good feature, as it allows of very

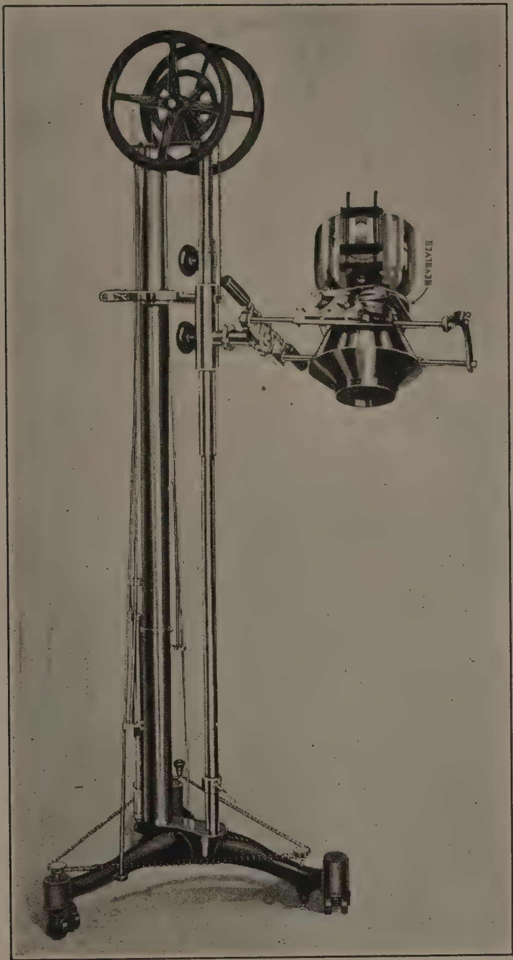


FIG. 424.

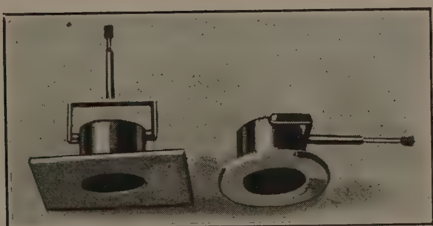


FIG. 425.

accurate and rapid placing of the tube. This is made by Geo. W. Brady & Co., Chicago.

X-ray Tubes.—It is not considered necessary to describe the various types of tubes which have been devised during the past twenty-five years, nearly all of which marked an era of improvement in the art, only to be discarded as out of date in a comparatively short time.

While here and there may be found an operator using a gas, a helium, or a nitroken tube, practically every modern X-ray machine is now equipped with a Coolidge tube.

The Coolidge Tube.—As described by the manufacturer, the Coolidge tube (Fig. 426) differs in principle from other X-Ray tubes, in that the discharge current, which can be passed through the tube, is determined primarily by the temperature of the cathode filament, and responds instantly to the changes in temperature imposed on the filament.

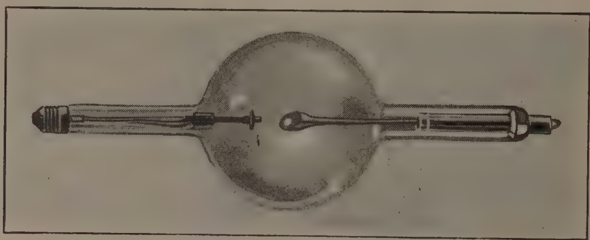


FIG. 426.—Coolidge tube.

The intensity and penetrating power of the Roentgen rays produced are both under the complete control of the operator. Either can be instantly increased or decreased independently of the other.

The tube can be operated continuously for hours, with either high or low discharge currents without showing an appreciable change in either the intensity or the penetrating power of the resulting radiations.

The tube in operation shows no fluorescence of the glass and no local heating of the anterior hemisphere.

The Coolidge tube consists of a tube exhausted to a pressure of not more than a few hundred millionths of an atmosphere in which is supported the cathode and anode—both being thoroughly freed from gas.

The cathode consists of a closely wound spiral of tungsten wire mounted concentric with a cylindrical tube of molybdenum which acts as a focussing device. This cathode is so arranged that it may be heated from an external source, such as a low voltage transformer or storage battery. The anti-cathode or target, which also serves as anode, consists of a single piece of wrought tungsten attached to a molybdenum rod and supported by a

split iron tube. The important characteristics of the Coolidge tube, other than those mentioned above, are as follows:

No discharge current passes through the tube unless the filament is heated.

The starting and running voltages are the same.

The focal spot is fixed in position.

The allowable energy input is determined by the size of the focal spot.

In Fig. 427 is shown the Radiator Dental type.

This dental type has a three and three quarter inch bulb, and the whole tube is small and, therefore, most convenient for dental work. It has, however, the compensating disadvantage of being able to use only a small current, and the distance from the target to the film must be short.

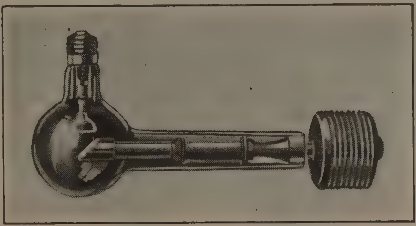


FIG. 427.—Radiator Dental Type.

Overworking the X-ray.—Roentgenologists and *radiodontists*, in general, are rather prone to overestimate the value of the ray in *dental diagnosis*, and thus, in their enthusiasm, do much harm.

Unfortunately, one of the greatest errors which these men teach is the value of the ray in detecting caries.

Now, caries *always begins* upon an exposed surface of a tooth; therefore, the dentist who cannot discover caries by means of a mouth mirror and a suitable explorer, is not thorough, and really requires a *good, careful dentist*, as an assistant, to make his examinations for him, and not an X-ray machine for that purpose.

To claim that incipient caries can be shown upon a skiagraph before it can be discovered in any other way, is not only absurd upon the face of it, but is a criminal doctrine to preach.

The result of such doctrines is that it is the tendency of the day—that is, amongst the men who have only comparatively recently installed X-ray machines—to depend too much upon the ray for a diagnosis, and they do this at the expense of a physical examination. No one should be rayed until after a careful and thorough examination of the mouth and teeth has been made.

Let me cite a case. A young lady went to her regular dentist and told him that she suffered at times from a lower second molar. He very promptly rayed the upper and lower teeth and told her the tooth she complained of and three others should be extracted because they were "dead teeth"—the usual craze. This did not sound good to her, so she went to another dentist and told him the same story, and without making

any examination, he very promptly rayed all these same teeth and told her she should have four "dead teeth" extracted, including the one she was suffering from—thus verifying the diagnosis of the first man.

This rather dismayed her. Young woman that she was, the idea of giving up four good teeth, as she considered them, did not appeal to her. So then she came to me, bringing with her the set of pictures.

Now the very moment she described the character of pain from which she had been suffering for several months, I realized that it could not have been from a pulpless tooth (root canals partly filled) as she insisted it was, but that it must have been caused by an irritated pulp. When I told her the lower molar was not the cause of her trouble, she smiled.

Upon making a very careful examination, I told her that I thought her pain was caused by an upper bicuspid, and then she laughed outright. However, she was game, if incredulous, and, as I told her that none of the four "dead teeth" were really dead, and that all, being vital, notwithstanding their dead pulps, should remain undisturbed, she was willing to allow me to remove a large inlay from the upper bicuspid, which decay had undermined at the cervical wall. The pulp was found in bad condition, partly dead, so it was removed and root canals filled. At the end of a week she was entirely free from pain and then finally was convinced that the lower molar was innocent of all her trouble.

Now if either of these dentists had just studied the case thoroughly, and considered the character of the pain from which she suffered, "used their wits," (as the saying goes) because both were pretty good young men—neither of them would have made such an ignominious failure of the case.

Imagine, if you can, where he would have stood if the young lady had submitted to the extraction of these four perfectly good molars. The pain would have continued, and later on, the recalcitrant bicuspid would have been discovered. It occurs to me that there would have been very much explaining to be done to convince the patient that the operators were trustworthy as the mistake in this case was absolutely inexcusable, and all due to the craze for the use of the ray as taught by some of our leading men.

Time and time again I have seen such results—erroneous diagnoses from faultily interpreted skiagraphs, when no skiagraphs were necessary. The student must be impressed with the fact that whenever a patient comes in suffering from toothache, it is not always an easy matter to locate the trouble, and careful consideration must be given every tooth, both upper and lower, upon that side of the median line, before deciding upon the cause of the trouble.

Character of the Ray.—There are what are called "hard rays" and "soft rays." Hard rays have penetration. Soft rays lack penetration. There-

fore, the character of the ray must vary in order to produce the best result according as to what part of the body is to be operated upon.

In taking dental skiagraphs, if the rays have too much penetration, they blot out the detail, and it is upon these details, as shown upon the film, that its value depends. Then again, if the rays do not have sufficient penetration, no details can be shown.

Therefore it is that each operator must experiment with his own machine, taking pictures with various lengths of spark gaps and with varying quantities of current, until he decides just where he, himself, can obtain the best results with his own machine.

FIG. 428.

In the gas tube the character of the ray depends upon the degree of vacuum, and this degree of vacuum may be varied at will by means provided for the purpose in the tube. However, this is not a very satisfactory method, and the Coolidge tube was devised to overcome the inherent faults of the gas tube.

The character of the rays emitted by the Coolidge tube depends entirely upon the amount of heat generated in the cathode spiral coil, and, as this can be controlled by means of a rheostat in the line, it is readily appreciated that the operator has at his command the means of producing just such rays as he may need for the class of work in hand at the moment.

Therefore it is seen that, first, the operator should be able to vary, at will, the character of the ray he uses; and secondly, that *theoretically* the Coolidge tube gives him this exact control. Does this theory work out in practice? I think not.

The weak spot in this combination is that this machine is operated by the street current, and the voltage of this current fluctuates very rapidly at times, and when this voltage changes, the current supplied to the cathode of the Coolidge tube changes also, and this change in that current changes the temperature of the spiral coil, and instantly the character of the ray is altered.

Therefore it is that, under such conditions,—that is, with this fluctuating voltage of the street current—it is impossible to absolutely control the character of the ray emitted by the Coolidge or any other type of tube.

The Stabilizer.—To overcome this defect, a machine, called the "stabilizer," has been devised to take care of the fluctuation of the voltage in the street current.

Such a stabilizer is shown in Fig. 428, and this does stabilize the current most satisfactorily.

Posing the Patient.—The correct angle at which to place the tube for skiagraphs of the upper teeth cannot well be taught by the correspondence method, there being so many factors to be considered. Upon the *position of a tooth in the arch*, and the height and shape of the vault of the mouth, which varies with each individual, must be based the position of the tube, and only practice can teach the process.

The writer believes that Dr. Weston A. Price was the first to publish diagrammatic instructions in this regard, and with his kind permission they are now given, as they can hardly be improved upon. He says, "Much skill is required to place the film and tube in the proper relations to the teeth to produce a correct shadow of the parts without distortion. We all know how seldom our own shadows represent our true height or shape, because the source of the light and the surface receiving the shadow are not in the proper relation to the object casting the shadow. Each of these three factors must be in correct relation to the other two, but one of them, the teeth and surrounding structure casting the shadow are by their peculiar position practically fixed and the others must, therefore, be adjusted to them. The shape of the arch prevents one placing the film in the best position to receive the shadow, viz.; in parallel planes. This produces a distortion which must be overcome by placing the source of the light in just the position that will shorten the shadow just the extent that will correct the elongation of it, produced by the film not being in a parallel plane to the roots of the teeth. We do not have this trouble with the lower bicuspids and molars, but we do with the lower cuspids and incisors, and with all the upper teeth.

"The correct image can be secured in two ways, by holding the film away from the crowns of the teeth the same distance that it is away from the roots, or by raising the source of the rays. The former is more difficult, and the results are not more satisfactory. The three diagrams shown in Fig. 429 will illustrate this distortion and how to correct it.

"Figure 1 shows diagrammatically the relation of the teeth and the film to each other, and the result of taking a skiagraph with the tube opposite at right angles to the plane of the teeth, and shows the distortion by elongating the shadow of the root. The skiagraph A, opposite, was made

with the tube in this position, and you will notice the very long roots, nearly twice the correct length. Figure 2 shows the distortion by placing

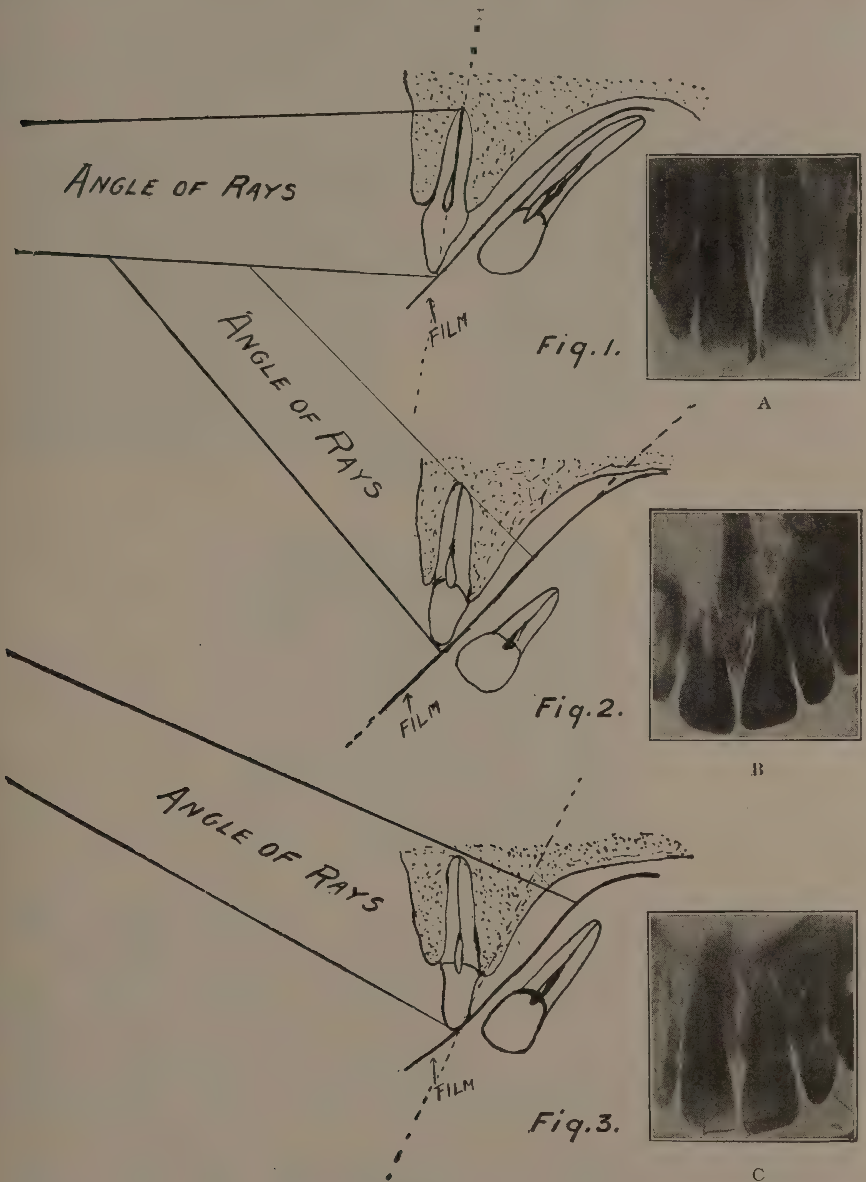


FIG. 429.

the tube so that the rays fall at right angles to the plane of the film, thus greatly shortening the shadow of the roots. The skiagraph B, opposite, shows the same teeth as A, but taken with this position of the tube.

The next, Figure 3, shows the correct position for the tube, in order to produce a shadow of the teeth that will have the minimum of distortion, and the skiagraph C, opposite, shows the same teeth as A, and B, taken from this position, and you will note easily the difference in the results."

All of this was written by Price years ago. Now it has been reduced to the popular formula: "Bisect the angle made by the plane of the object and the plane of the film, and direct the rays so that they will fall perpendicularly upon this imaginary plane."

As a *formula*, I reckon that is all right, but as far as being explicit instructions for the guidance of a student, it sounds to me like "prue bunk." It certainly could not help me.

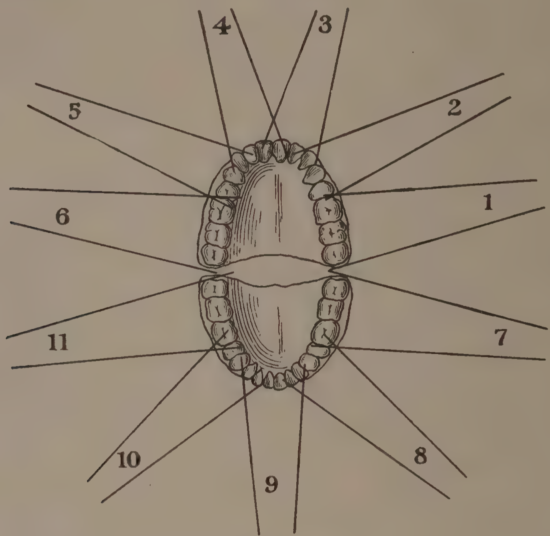


FIG. 430.

Standardized Technic.—Translating this formula into plain English, it is seen that "bisecting an imaginary plane" is pure guess work, and that there can be no standard and pre-determined sets of angles to be used upon the various teeth as they are found in the mouths of different people. As the radiability of the jaws vary in different individuals there can be no definite length of exposure of the same teeth for all patients. In other words, there can be no such thing as a "standardized technic" for the taking of dental skiagraphs.

Therefore, in the beginning, each student must set his tube absolutely by guess. Then he must watch the results of his guesses, change his guesses accordingly, and in the end he will use *judgment* instead of guess work in placing his tube, and when he becomes proficient, he will obtain fairly good results nearly every time.

The Ritter Diagram.—In Fig. 430 is seen the method of taking full sets of pictures, according to the instructions furnished with the Ritter machine. This calls for eleven skiagraphs.

The Mayo Method.—At the Mayo's, ten pictures constitute a full set, as they take the four upper incisors upon one film, instead of using two films for them as do the Ritter people.

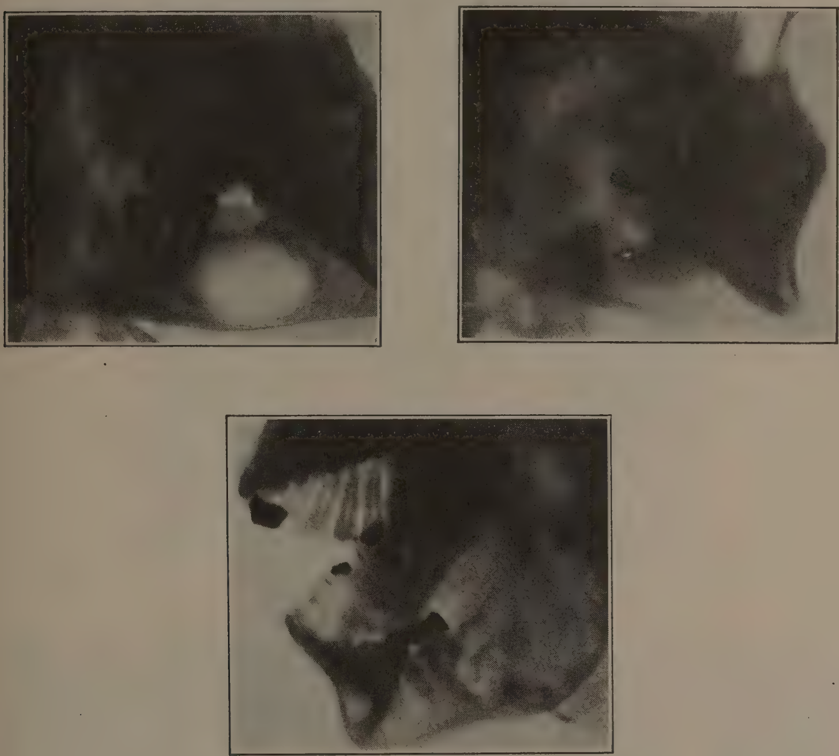


FIG. 431.—(*These three pictures are shown through the courtesy of Dr. Clarence O. Simpson.*)

Personal Experience.—That either ten or eleven films will always prove sufficient for a thorough examination, has not been found to apply to my practice.

In V shaped arches coupled with extreme irregularity, one may find that each incisor must be taken upon a separate film in order to get good details at its root ends.

It is not so very unusual to find that only a cuspid can be taken upon one film.

Again, in certain cases, it may be necessary to take two or three pictures, from as many different angles of the same tooth, before one can arrive at a satisfactory diagnosis.

Unusual Cases.—In some unusual cases, one could not make a thorough examination without taking a horizontal picture. In other instances, such as shown in Figures 431 and 432, complete diagnoses could not be made without extra-oral pictures.

FIG. 432.

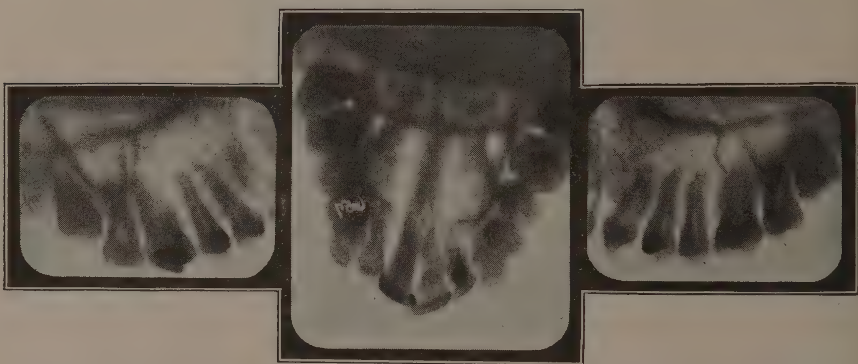
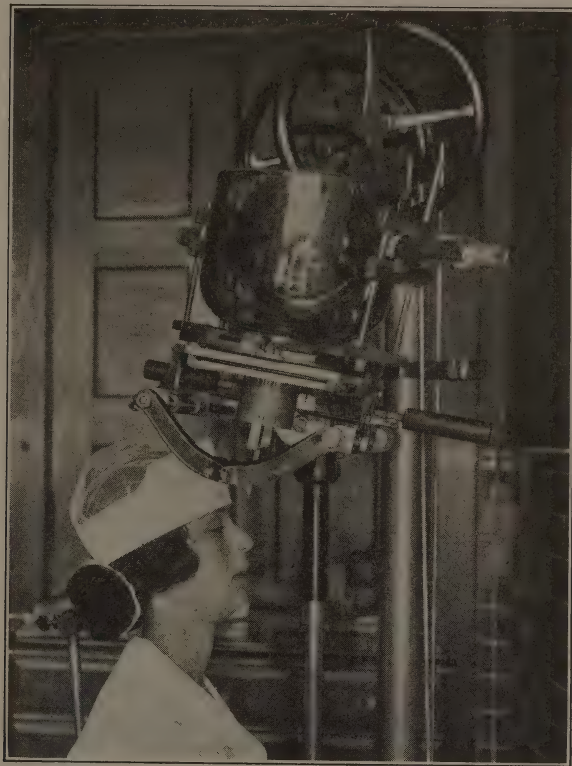


FIG. 433.—Survey of the upper arch.

Thus it is seen that there can be no set rule for the making of full examinations, and one must use one's own judgment and take just as many pictures as may be necessary in order to obtain satisfactory details of each root end, or of each region.

Making a "Survey."—In many cases, taking only three skiagraphs of the upper jaw, as shown in Fig. 433, will give one a good *line* upon the



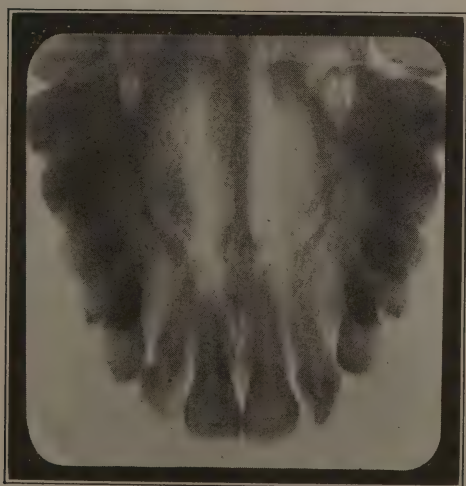


FIG. 434.—Large film held between the teeth.

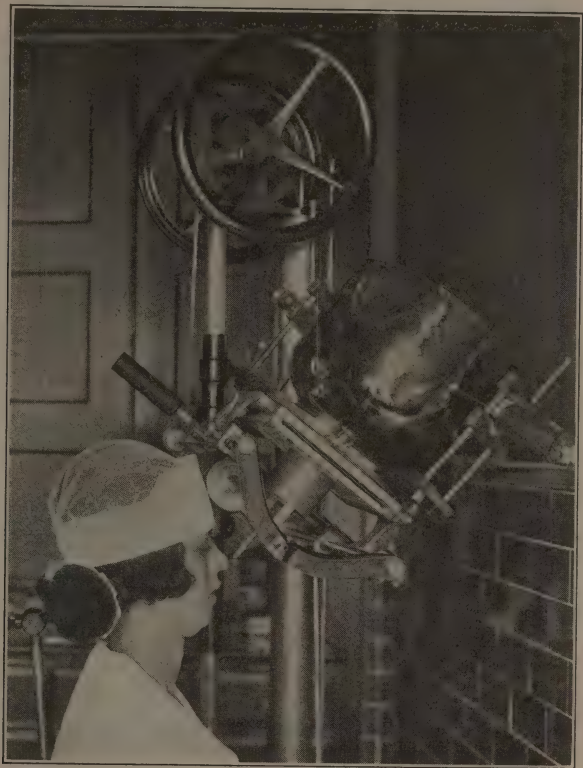
condition of all the root ends. These pictures will show all radiopaque root canal fillings, or radiolucent areas.

After making this "survey," pictures of any root ends that require

FIG. 435.—Taking the left upper molar region.

special study can then be made, and, in many cases, such a procedure will simplify matters. The following illustrations are, therefore, purely approximate, as the angles at which the tube is set must be considered in

relation to the shape of the roof of the mouth and that of the lower jaw, always excepting the lower molars, for which the tube may always be placed horizontally, while the head is vertical. (Figs. 434–439.)



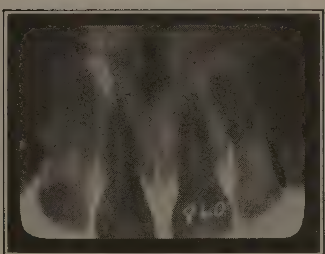


FIG. 436.—Taking the upper incisors.

Position of the Patient.—Some operators always place the patient's head in a vertical position, and with the occlusal planes of the teeth perfectly horizontal, and always shift the tube.

FIG. 437.—Large film held between the teeth. (This film shows the tube was not properly focussed, as the teeth are not evenly distributed on the film.)

I do not. I tilt the patient's head instead of changing the angle of the tube. I first set the tube for the upper molar region, and take that picture. Then, the chair is revolved so as to bring the bicuspid region into focus, and the head is tilted—tube not changed.

FIG. 438.—Taking the lower first molar.

The chair is then revolved still further, so as to bring the cuspid into line and the head adjusted again. I find that to get a good picture of a cuspid, it usually must be taken *alone*. And this process is continued until all of the upper teeth are taken.

In the lower jaw, it is pretty much the same thing. The tube is placed horizontally and the molars are taken; then the head tilted for the bicuspids and so on all around the arch.

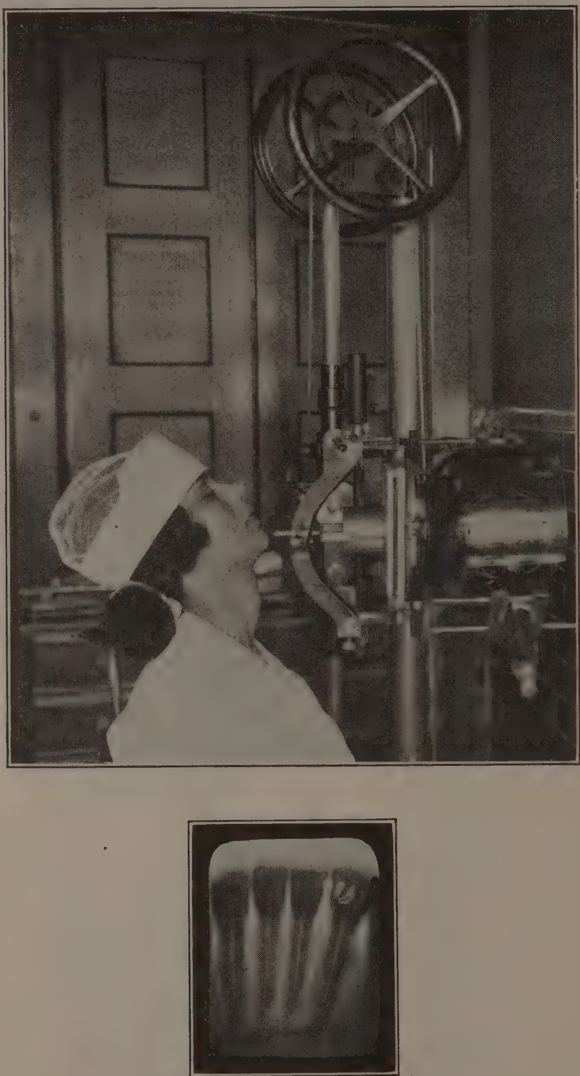


FIG. 439.—Position for the lower incisors. (The Buck molar packet is well adapted to this region.)

In this manner a lot of time is saved and I believe equally as good results are obtained.

Full Mouth Examinations.—Many men of standing are to-day preaching the gospel that a full set of skiagraphs should be taken for every new

patient who comes in. Now that may be good practice for all such institutions as the Mayo's and Johns Hopkins, but for a dentist to say that every new patient *must* be subjected to the expense of such an examination, is not only perfectly absurd, but would soon result in obtaining for him a very unfortunate, though entirely justifiable, reputation.

In my own practice, I am sure a full mouth X-ray examination was not indicated in even one per cent of all new patients as they came in from day to day. With this fact in view, I can but think it is most unfortunate for such advice to be given by men of influence, and all I can say is that I hope but few, if any, will attempt to follow it.

When patients are in normal health and their mouths appear practically normal, I see no necessity for an X-ray examination. The only excuse for such, under these circumstances, that I can see, is the fee.

However, when a patient complains of *pain* which cannot be accounted for by either physician or dentist, then a *full mouth examination* should be made, as, under these circumstances, there are no other means of discovering some supernumerary or unerupted tooth or root fragment, if any such may be suspected.

Again, if some focus of infection be suspected, a full set of pictures may be necessary. Such instances, however, are rare, because seldom does a patient present with a full set of pulpless teeth, and, of course, it is only pulpless teeth or root fragments that usually can prove to be foci of infection.

Thus it is that, in a high class dental office, a full set of skiagraphs is rarely indicated—the intelligent and conscientious dentist taking the skiagraphs of doubtful teeth or areas, and none other, when looking for a focus of infection, and all of the regions, only when looking for unerupted or supernumerary teeth, and none at all when they really are not necessary.

Orthodontic Cases.—Many orthodontists require an X-ray examination before undertaking their work for young children, and this is undoubtedly a wise precaution. Orthodontists, of all persons, should know whether or not all of the permanent teeth (except the third molars), are in the jaw, before undertaking any extensive work.

Full Mouth Examination for Children.—In my practice, young patients who have one or more permanent teeth missing in the jaw are so few and far between that I cannot consider it good practice, or fair to the parents, to say that every child under nine years of age must have a full set of skiagraphs taken. When one or more permanent teeth are, say, one year or more behind time in erupting, and the temporary teeth over them are in place and apparently firm, then I believe it is good practice to skiagraph the region or regions involved.

Ascertaining whether or not these unerupted teeth are in the jaw or missing, before this period, is not essential. It is time enough to learn this now. Of course this refers to ordinary cases and not orthodontia cases, which should be treated differently.

Special Upper Molar Technic.—While, way back in the early days, Doctor Price suggested that one way of overcoming distortion in taking dental skiagraphs, was to hold the film away from the crowns of the teeth, it remained for Dr. C. A. LeMaster to develop this idea for upper molars, which he has only recently done.

The difficulty in obtaining satisfactory skiagraphs of the upper molars lies in the fact that they (the first and second molars) usually have three

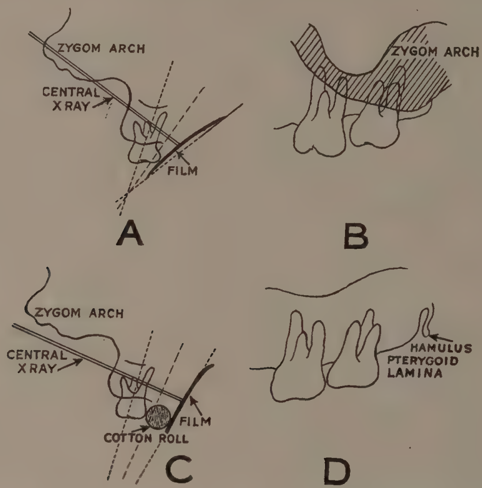


FIG. 440.—LeMaster Method for taking upper molars. (*Courtesy of Dr. C. A. LeMaster.*)

roots and their apices lie under the Zygomatic arch, as shown in Fig. 440, and here is a sample of LeMaster's work in this line.

As a matter of fact, I have not been wholely successful with this method, although at times it gives better results than the usual one.

The weak spot in this technic is that the cotton roll, shown so nice and round in the illustration, does not stay round upon the pressure of the fingers, but, as a matter of fact, flattens down to less than half that thickness, so that the cotton roll does not hold the film where it is supposed to be.

The truth is that upper molars vary greatly in shape, and some molar roots can be pretty clearly skiagraphed, while the pictures of others must necessarily be unsatisfactory irrespective of the technic used.

The Photographic Film.—The operator who is using dental films should know, at least, *something* about films in general.

The film consists of a thin, transparent, flexible (celluloid) backing, coated upon one side with a layer of gelatine about 1/1000 of an inch in thickness which contains a silver compound extremely sensitive to light, and, fortunately, to X-rays as well.

When this sensitized gelatine surface, or "emulsion," as it is called, is acted upon by the X-ray, a chemical change takes place, which change, however, cannot be detected by any known means.

If, however, this film, after being exposed to the rays, is put through the process called "developing," a chemical reaction takes place wherever the rays reached the emulsion which results in a deposition of metalic silver in microscopic granules, resulting in a metalic image.

The development must naturally take place in the dark, or under non-actinic light, such as the light from a ruby lamp; or the more modern and satisfactory green safelight, because if white light reaches the film during this process of development, the film will be ruined.

Once the film is developed, it will still be affected by white light, so it must be put through another chemical process called "fixing" before it is rendered safe.

Fixing is accomplished by immersing the film in a solution of hyposulphite of soda—called hypo for short. This acts upon it in such a manner that it removes the milky appearance of the film and permanently fixes the image so that white light will not affect it.

It is necessary to rinse the film well and thus free it from developing solution as much as possible before placing it in the fixing bath. By rinsing well is meant flipping it backwards and forwards five or six times in the rinsing water—the iced water in summer, or in the washing box in winter.

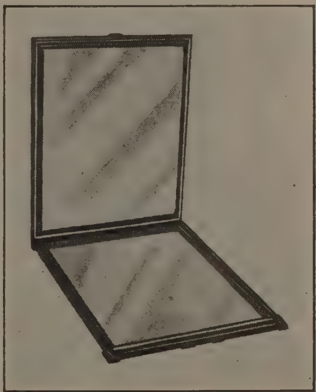


FIG. 441.

The Duplitized Film.—There is now upon the market what is called a duplitized film. Instead of having quite a heavy coat of emulsion upon one side of the celluloid backing, as has the ordinary film, it has a very thin coating upon both sides.

This makes a more rapid film, and with it better results are obtained, but it requires special care in handling as both sides of the film must be protected from injury during the developing and drying processes. At present this film is not supplied in smaller sizes than five by seven.

Cassette.—A cassette is a plate or film holder, and is indispensible when screens are used. Screens must be in "optical contact" with the emulsion

surface, and, in these cassettes, springs against the back plate force the screens and film into contact. (Fig. 441.)

The Eastman Film Holder.—In Fig. 442 is shown a very simple and satisfactory film holder, when large films—five by seven, or larger—are used. Beside it is shown one of these five inch by seven inch holders cut down to fit the three and one half inch by three and one half inch films which are used for skull pictures.

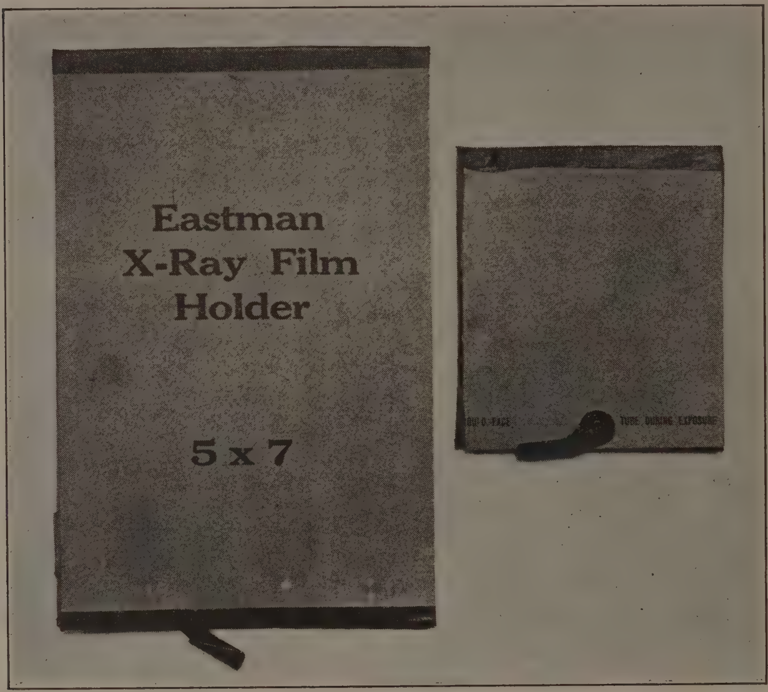


FIG. 442.

Dental Films.—There are, at this writing, only two manufacturers in this country who supply dental films—the Eastman Co. and the Buck. The Eastman film is supplied in three sizes—two and one fourth inches by three inches, one and one half inches by two and one fourth inches and one and five eighths inches by one and one fourth inches.

The Eastman Co. has recently marketed a new film, the celluloid backing of which is granular instead of being clear as all films heretofore have been. Whether or not this is an advantage will probably be a question with different operators. As for myself, I prefer the old style at present.

The Buck film is furnished in two sizes, the one being the regular one and five eighths by one and one fourth size, while the other is only one inch by one and one fourth inches, and is called the *molar film*.

As a matter of fact, I prefer the regular size of the Buck for molars, but do find this small film useful for cuspids in narrow arches and some times also for other positions.

One objection to the use of this small film is that it cannot be placed in any of the standard mounts, but this is no objection to the operator who takes the pictures for his own use, and, therefore, does not need to mount them in these cardboard mounts.

Speed of Films.—Dental films are furnished in two speeds—regular and fast—the latter being about four times as fast as the former.

If one has a machine with which he can regulate the character of his ray "to a dot," and he has the judgment by which he can estimate the radiability of the parts to be skiagraphed, "to a dot," then he may get the best of results with a fast film. If he lacks these two necessary elements for success for fast films, then he will probably obtain better results with slow films. Slow films allow of the operator's having more latitude in the work; that is their advantage, and I use them exclusively. With small machines that are not sufficiently powerful to use a slow film, the fast film must, of course, be used.

Gagging.—Every now and then, upon placing a film in the mouth of a patient, he starts gagging—a very unpleasant procedure, to say the least—and it is impossible to take the skiagraph.

Immediately upon such an occasion, no time is lost, but the patient's throat is at once sprayed with Chloretone Inhalent, put up by Parke Davis & Co., and seldom is a case met with that this does not control.

In Fig. 443 is shown the little atomizer furnished with this inhalent for this purpose. It is needless to say that this is considered an indispensible accessory to the X-ray room.

Of course, there are other means of overcoming this gagging, such as painting the mucous membrane with novocain or cocain, but I like the Chloretone better than anything I know of.

Placing the Film in the Mouth.—For all upper exposures, place the film in the mouth exactly where you wish it, emulsion surface towards the teeth, and then have the patient hold it in position with the thumb of the hand on the opposite side of the body, and then let the patient close the jaw upon the thumb. For the centrals, the film may be held with either thumb.

When it comes to the lower teeth, it is a different proposition, especially in skiagraphing the molars, as not infrequently the patient will move the film a little at the last moment, and, consequently, the area desired will not

be covered. Especially is this the case with the unerupted lower third molar.

Film Holders (Intra-oral).—For the lower molars and bicuspids, a film holder is always used. Numerous film holders have been devised

Fig. 443.

by various operators, by means of which the patient himself holds the film in place, but none of the devices which have been seen are satisfactory to me.

A film holder for the lower molars and bicuspids as shown in Fig. 444 was, therefore, devised. The shelf A on the short side is placed upon the occlusal surfaces of the teeth. The end of the first finger of the hand on

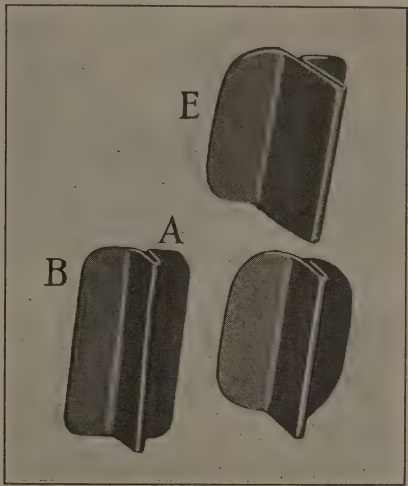


FIG. 444.

the opposite side of the body rests upon the ledge B, and gentle pressure there holds the film *against the teeth and gums*, and there is no chance of its slipping. The patient closes the teeth upon the finger, and thus the lower

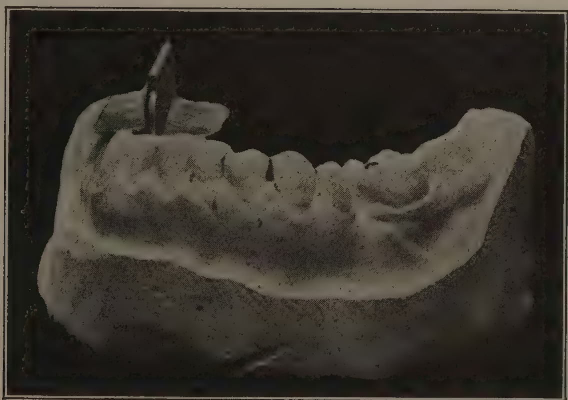


FIG. 445.

jaw is steadied. In Fig. 445 is shown a model with such a film holder in position.

Film holders are made of different *depths* in order to adjust films to deep or shallow mouths. A film holder, shown at E, is suitable for

holding the film when skiagraphing an unerupted lower third molar, as in such a case the film should not be held as low as is necessary for an erupted tooth.

To Make a Film Holder.—Take a piece of annealed sheet aluminum about 28 gauge B. & S., and of the size shown in Fig. 446. With a pair of

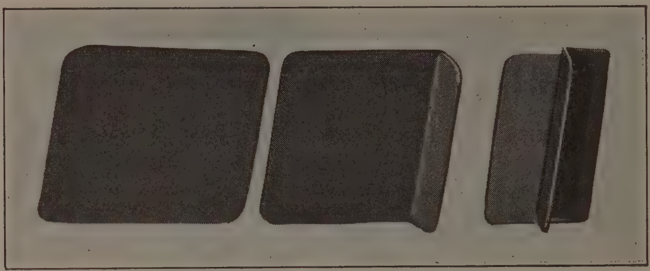


FIG. 446.

pliers bend one end to a right angle, then mark it at the depth desired Hold a film packet against it, and then double the plate over it; next, bend the end back to a right angle (Fig. 444) with a pair of pliers and the trick is done.

Very occasionally a patient will present, who, owing to inflammation existing about the lower third molar, can open the jaw a very, *very* little

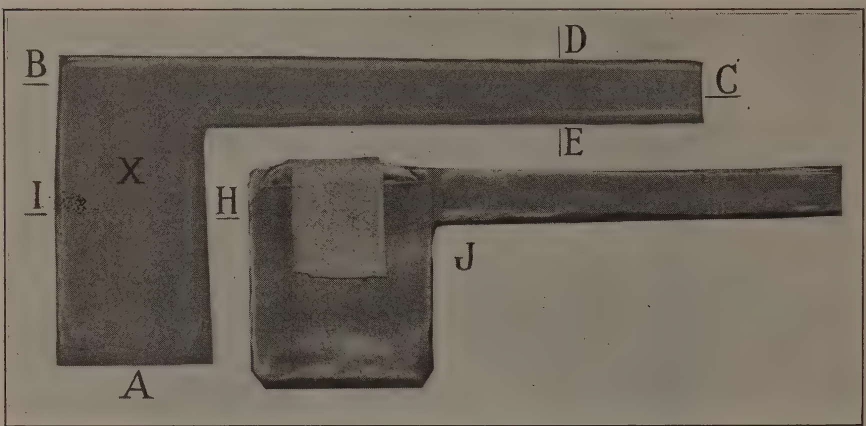


FIG. 447.

distance, and yet an intra-oral picture is desired. For this purpose I have made a special film holder as shown in Fig. 447.

Take a piece of aluminum plate, 28 B. & S., and cut to pattern shown at A. Bend the plate upon itself along the line B. C., and double the end upon itself at D. E. Thus is the handle made and stiffened.

Lay a Buck molar packet upon the holder at X., and double the plate over it at the line I.H., which makes a U-shaped pocket for the film packet.

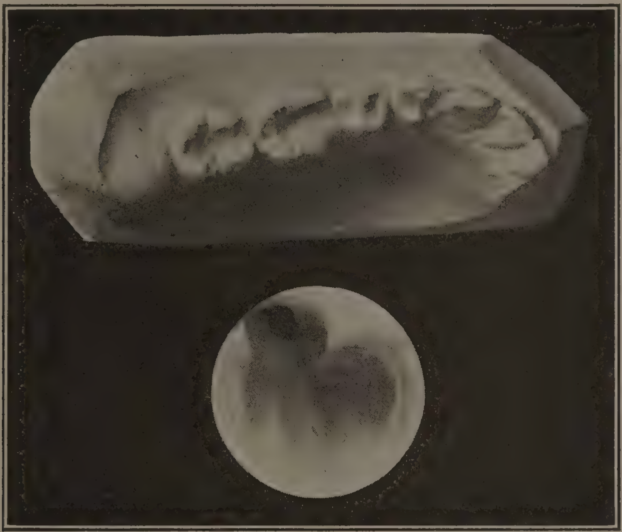


FIG. 448.

Round the sharp corners a little, and when completed and loaded, it appears as at J. To make "assurance doubly sure," the upper edges of the film holder can be securely bound together (after the film is placed in the holder) by means of a piece of one half inch adhesive tape. The film is thus held securely in the holder, and cannot possibly become dislodged and go down the patient's throat.

FIG. 449.

In Fig. 448 is shown a model of a case with skiagraph, which was taken with the front teeth not over one quarter of an inch apart.

Development of Dental Films.—That the development of the film must be in a room or compartment that is absolutely free from white light, rather complicates matters. There are two means of providing this dark room—the one being a regular dark room, the other, a light-proof developing cabinet such as is shown in Fig. 449.

If one is so placed that he cannot have a dark room, then the next best thing he can do is to make himself a developing cabinet that will meet his own requirements. If he is so unfortunate that he cannot devise and

carry out the construction of such a cabinet, then he naturally must purchase one that he can find upon the market.

In the early days I made such a cabinet, but finding it unsatisfactory, abandoned the idea.

The Dark Room.—A regular and well equipped dark room is really a necessity, and only with such are the very best results obtainable.

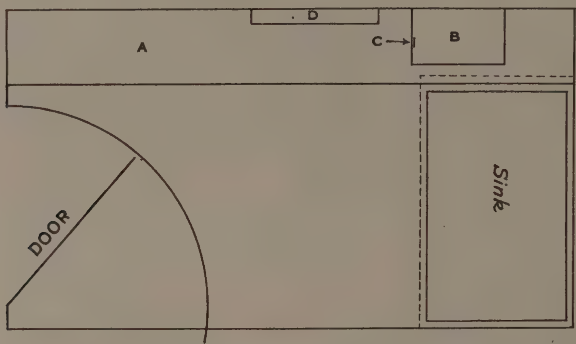


FIG. 450.

As a rule, space in a modern dental office is valuable, but as the dark room need not be large, it can usually be provided. My own room is three feet by five and a half feet which is plenty large enough, though, as a matter of fact, a closet three feet square would be ample. In Fig. 450 is shown its plan. The edges of the door are made light proof by means of ordinary weatherstrips, to be had at any hardware store.

Cleanliness.—Everything in the dark room should be kept scrupulously clean. The acid fixing bath should never be placed in the developing tank, nor the developer in the fixing tank. The tanks should be scrubbed out with a suitable brush (Fig. 451) just as often as necessary, because, as the solutions evaporate, a deposit accumulates around the walls of the tank.

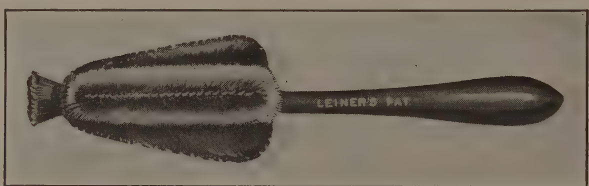


FIG. 451.

All beakers, trays and everything else used in the dark room must be kept clean. All solutions, however, may be made up in the same glass beaker, provided it is thoroughly washed immediately after being used.

Developing Lamp.—As before stated, the least amount of white light will affect the film, so it is necessary that the dark room be absolutely free

from this light, and the developing must be carried on under a non-actinic light.

Up to comparatively recently, the ruby lamp was used exclusively for dark room work, but there are now upon the market certain "safe lights" which are made up of two plates of clear glass bound together, and holding one or more specially prepared sheets of paper between them, and these are far superior to the ruby lamp as they allow of a much greater amount of light to be used and yet they are safe.

The Wratten Safelight Lamp.—In Fig. 452 is shown the Wratten Safelight lamp which, when used with the green safelight, series 4 (which is specially adapted for use with X-ray films) is the best dark room lamp which I have ever seen.

Testing the Safelight.—To be assured that the safelight is perfectly safe, proceed as follows:

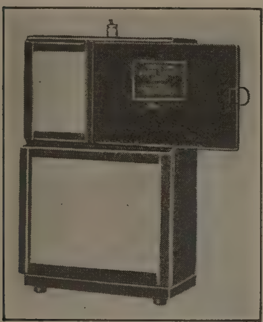


FIG. 452.

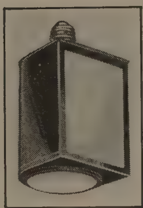


FIG. 453.

FIG. 454.

Open a film packet in absolute darkness. Cover one half of a film with a piece of black paper, then turn on the safelight and expose the other half of the film to this light, holding it about six inches away from it, for one minute by the clock.

Then develop, fix and wash as usual. If there is any difference between the half of the film that was exposed to the safelight, and the half that was not exposed, then you know that the electric lamp is of too high a candle power, and a weaker lamp must be used.

Gravitation.—An humble confession it is, but I find the attraction of gravitation *unusually strong* in the dark room. When a film, or clip, or envelope, or something yields to this force, it usually goes off at a tangent and cannot be found in the dark.

Here is where a little Brownie, fitted with a ten watt Mazda bulb and series No. 4 safelight, connected by a long cord and used as a portable, is most satisfactory. (Fig. 453.)

The Magnifying Radioscope.—In Fig. 454 is shown one of the hundreds of things just made to *sell* to dentists—at least that is my idea of it.

No one need study a film *indefinitely*. He should take it by a good light, examine it carefully, decide upon what he finds there, let that sink into his brain, and then he should be through with the film, *as a rule*.

The bracket table is no place for a radioscope. When a patient is in the chair, no time should be needlessly consumed in studying a film, and the last thing one wants to do is to show the film to the patient. That is my idea, but I may be wrong.

When the patient is in the chair, time should be used in the accomplishment of something worth while, and not frittered away in idle conversation.

Of course, there are times when something unusual is to be seen upon a film and it may be advisable to show it to the patient, but I venture to say that in regular routine practice, not even one in every hundred films need be shown.

However, there are times, such, for example, as when one is extracting a difficult tooth, when it is advisable to have the film in plain view.

Fig. 455.

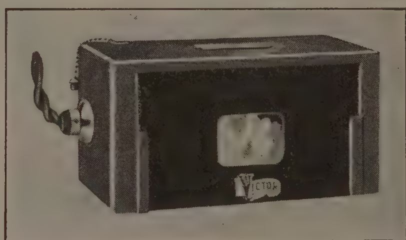


Fig. 456.

Under these circumstances, it is not necessary to examine the film under a glass, therefore, it can be placed in an ordinary clip soldered to a base, as shown in Fig. 455.

Studying Films.—In order to study films most effectively, they must be studied under the best possible conditions. Films should be viewed by transmitted light, and electric light is, as a rule, preferred to daylight.

The ordinary incandescent lamp gives a yellow light which is not very well adapted to this purpose, but there can be obtained a special blue bulb

which is called a "daylight" lamp, which gives a very white light and is the best lamp for this work.

Viewing Boxes.—There are a number of viewing boxes on the market, one of which is shown in Fig. 456.

As a rule, space is limited in a dental office and it certainly is in mine; and also, as a rule, no one wants to unnecessarily increase the number of appliances in use.

The Wratten Safelight No. 1, which I use in the dark room, is supposed to be a combination developing and viewing lamp, as the upper half is supplied with a piece of opal glass, while the lower half is provided with a green safelight. The box has only one socket, in which, naturally, a low power bulb must be carried, or else the light would be too strong for developing.

As a developing lamp, this is first class, while as a viewing box, it is a dismal failure, as nothing could be worse for the reading of films than that little lamp.

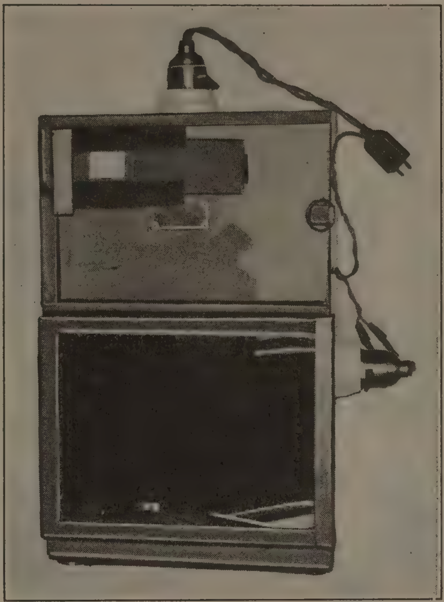


Fig. 457.

I took this box, and added another socket, as shown in Fig. 457. In this is placed a small bulb, suitable for developing. In the upper socket is placed a blue daylight lamp which, as was before stated, is the best lamp for transilluminating films. A metal diaphram was placed across the middle of the box, separating it into two compartments.

Here then, is a combination *safelight* and viewing box with which the developing and studying of films can be carried on under ideal illumination.

On account of the metal diaphram, it is not possible for the operator to turn on the blue bulb accidentally and spoil the film during developing, which he might do if it were not there.

Masking the Opal Glass.—Upon holding a small film in front of this large piece of opal glass, it cannot be examined to advantage, because there is too much extraneous light. To overcome this, a small window, about one inch by one inch and a quarter, was cut in the metal slide of the

box, and a sliding shutter attached. In front of this small opening, and with the daylight lamp, a film, wet or dry, can be examined to the very best advantage. This is also shown in Fig. 457.

Since altering the box, as above described, it has occurred to me that it could be still further simplified, and yet remain just as efficient, by cutting out the lower lamp entirely and making a few holes in the diaphram.

These holes should be of such a size and so arranged that they would illuminate the lower half of the box just sufficiently so as to furnish a good

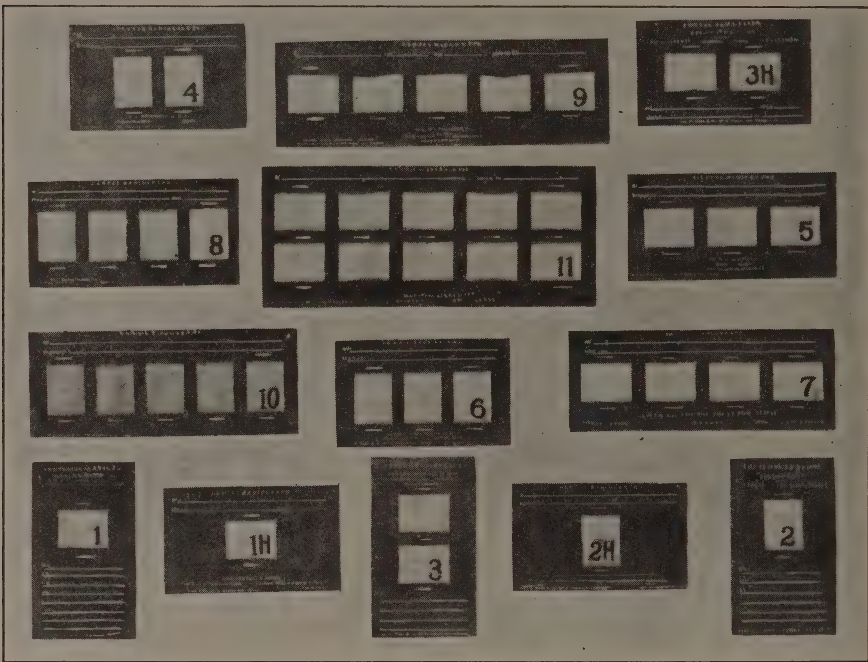


FIG. 458.

and safe developing light. In this manner, only the one daylight bulb would be necessary.

Film Mounts.—Various manufacturers furnish many kinds of *film mounts*, as they are called, for holding films while being examined. Some are of celluloid, others of card board, and they have anywhere from one to twelve windows for as many films. In Fig. 458 is shown such standard mounts.

Accessories.—A pair of scales, trays for making prints, beakers, pitchers, stirring rods, horn spoons, are all indispensible in a well equipped dark room. (Fig. 459.)

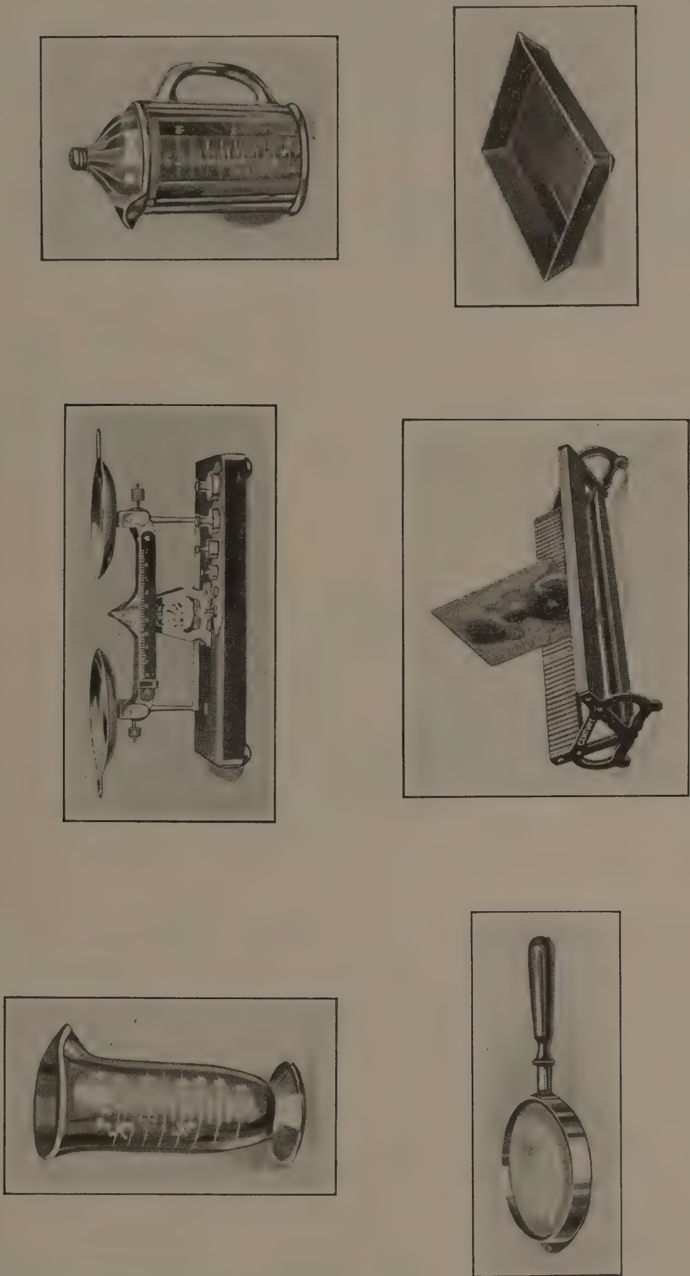


Fig. 459.

Thermometers.—There are two kinds of thermometers made especially for dark room use, both of which are shown in Fig. 460.

The one, in the shape of the stirring rod, with no metal about it, is practically the only one that should be used to test the temperature of the solutions, as it is readily kept perfectly clean.

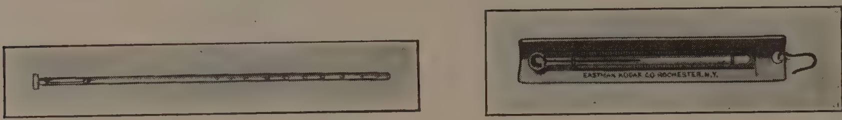


FIG. 460.

Film Registering Device.—The Buck Xograph Co. has marketed a very useful device for improving the reading qualities of thin films. If a film, which is so "thin" that the details cannot be clearly seen, is placed in this holder *with its duplicate*, and both films thus examined simultaneously, then the details are brought out very much more clearly than when looking at one film only. (Fig. 461.)

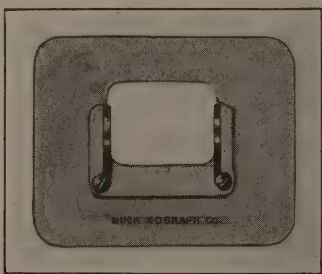


FIG. 461.

Development—A Chemical Process.—The most skillful operator, backed up by very best of X-ray machines, cannot produce a good finished dental skiagraph unless the film is *properly developed*.

The exposure of the film to the influence of the ray—that is, the taking of the skiagraph—is not a mechanical process, but one depending entirely upon the ability and judgment of the operator.

The development of the dental (or any other) film is purely a chemical process, and does not depend upon the skill or judgment of the operator who does the work, but does depend absolutely upon the temperature of the solution used, and the length of time of the development.

The composition of the developing solution governs the length of time in which films must be immersed therein, in order to obtain the best results. Each formula has its own particular time, and when *properly exposed* films are developed therein, they must remain in it just exactly that length

of time—no more and no less—while the solutions are maintained at 65 or 66°.

Climatic Conditions.—In the development of films, the climatic conditions govern the process used, to a very great extent. A method that will be satisfactory in cold weather will not succeed in hot weather, and the best of skiagraphs can be quickly ruined in damp, soggy weather.

Room Temperature.—When the temperature of the *room* and *tap water* is 80° F., or under, after the films are developed, they may be fixed in an ordinary acid fixing bath, and the emulsion will then stand washing under the tap and drying in the air, but when both room temperature and the tap water go above 80°, then it has been my experience that the emulsion will not always stand, and, therefore, an additional hardening bath must be used.

Hardening Solutions.—After trying various hardening baths, the following formula is now used:

Water	½ gallon
Chrome alum	3 ounces
Sulphuric acid C. P.	1 dram

After the film has been developed, it is well rinsed and placed in this hardening bath for one minute or more, and then it is placed in the fixing bath. By "well rinsed" is meant that it is flipped back and forth, in the water bath, five or six times.

Formalin Hardener.—A five per cent solution of formalin in water makes a simple and effective hardening solution. I used it for a while, but upon acquiring a very annoying dermatitis, which was traced to this solution, I naturally discarded it. So my advice is against the use of formalin.

Testing the Hardener.—To ascertain whether or not one minute in the hardener is sufficient, proceed as follows:

Develop a film as usual. Rinse well and hang in the hardener for one minute, and then fix as usual. Then hang it for a few minutes in a jar of water, at a temperature of 100°. If the emulsion remains firm, the hardening process was a success; if the emulsion melts off, then it is seen that one minute in the hardener was not sufficient, and the time should be increased to one and one half or two minutes, when the test should be repeated.

Each operator should learn the length of time necessary to harden a film under the method he uses, and abide by the results.

Some films frill more readily than others. I have seen the Eastman No. 1A films and Buck films developed and hardened simultaneously, when the Eastman frilled and the Buck remained unchanged during the

washing process. As the Buck is really an Eastman film, this rather surprised me.

In Fig. 462 is seen a good example of a "frilled" film.

Developing Formulæ.—As a rule, each package of X-ray films or plates, as put up by the manufacturers, is accompanied by printed instructions including the formulæ for the necessary developing and fixing baths.

Developing Solutions.—These developers can be secured from supply houses in package form. To make up the solutions, all that is necessary is to follow the directions accompanying the packages. Distilled water should always be used.

While this is a most convenient method of making solutions, it is more expensive than buying the various chemicals in bulk and personally making up the solutions.

Fig. 462.

Any operator who does X-ray work regularly, undoubtedly should make up his own solutions of all kinds.

All of these developing solutions require either five or six minutes for the proper development of a film, and such solutions were naturally used by me.

Now, there are times when five or six minutes is a pretty long time to wait, in a busy dental office, upon the development of a film, so when in August 1921, I learned, by the merest accident, that Dr. R. Ottolengui possessed a formula in which a film could be developed in forty-five seconds, I naturally was greatly interested, but also greatly incredulous, it must be admitted.

This formula was, therefore, immediately obtained from Dr. Ottolengui, and was tested out and found, greatly to my amazement, to be just as satisfactory as any of the many formulæ I have used during the past twenty-five years.

The "Wonder Developer."—The "wonder" developer (as we call it in the office, for it must be called something) is simpler to make up than either the Eastman or Buck formula, and is more quickly prepared, and moreover, the stock solution (caustic potash) apparently keeps indefinitely. In the course of time, this solution may become flaky, but filtering it appears to be all that is necessary under the circumstances. I believe that any operator who will try this developer, will be more than pleased and will use it again in preference to any other.

In Fig. 463 are shown two films. They came in the same packet, and were, therefore, exposed alike. The one was developed five minutes in the regular Eastman developer; the other was developed forty-five seconds in this "Wonder" developer. If any one can tell which is which, I will be surprised. The only way I can tell them apart is by a mark upon one which identifies it.

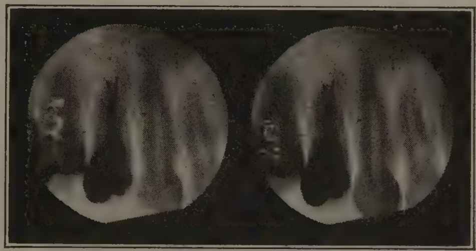


Fig. 463.

Just stop a moment and consider what this "wonder" developer can do for a busy dentist. In trying to get the length of a root before filling a canal, as many as four or more skiagraphs are sometimes taken. Four pictures would require a total of twenty minutes for developing in ordinary developer, and only three minutes in the "wonder" developer—a saving of seventeen good long minutes on that work alone.

I found that by changing the formula slightly, it made it very much more convenient. My modified solution keeps just as well as the original formula or at least it appears to. The quantity we make up only lasts three or four weeks and is perfectly good at the end of that time. Whether or not it would keep six months or a year, I do not know. Of course that does not concern me.

THE ORIGINAL FORMULA:

A

Caustic potash	½ lb.
Soda sulphite (dry)	½ lb.
Potassium bromide	1¾ oz.
Water	50 oz.

B

Water	2 oz.
Hydrochinon	1 dr.

To use: Mix two ounces solution A with two ounces solution B. Develop first day forty-five seconds, second day, ninety seconds. Third day, one hundred eighty seconds.

MY MODIFIED FORMULA:

Caustic potash	½ lb.
Soda sulphite (dry)	½ lb.
Potassium bromide	1¾ oz.
Water	100 oz.

To use: To each four ounces of the above stock solution, add one dram of hydrochinon.

Now I found that if a small quantity of this developer was prepared—hydrochinon and all—ready for developing and kept in an ordinary vessel and uncovered, it deteriorated rapidly, just as the original instructions said it would; but if kept in a *light proof jar and closely covered*, it would remain clear for a number of days. (Oxidized developer will stain a film.)

This developer is now used in a lead or colored glass tank, and a float cover is made out of paraffin about one quarter of an inch thick, with a little projection for a handle, as shown in Fig. 470. In Fig. 464 is shown a lead tank with a float cover.

FIG. 464.—This shows a cork float but I now find that I like paraffin better.

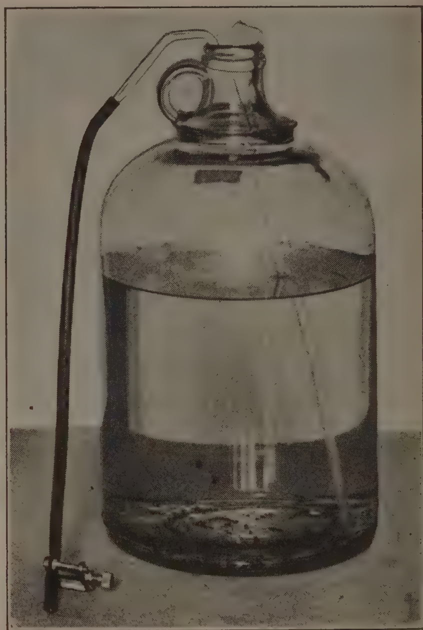


FIG. 465.

This paraffin cover practically prevents oxidation of the solution by the atmosphere, and, of course, the lead tank protects it from all light. The lead tank cover affords further protection.

Caustic potash solution seriously injures my hands, so that rubber gloves are part of the outfit, and when no glove is worn, the little float is handled by a clothes pin.

When the solution is used in this manner, if not too many films are developed, it can be used for several days, during all of which time the film is developed forty-five seconds only. At the end of that time, the developer is discarded.

The developer is kept in a gallon jar with a bent glass syphon, by means of which it is readily drawn off into the tank. An ordinary clamp closes the free end of the rubber tube. (Fig. 465.)

A number of glass vials, each one containing the exact amount of hydrochinon for a certain sized tank, are always at hand. (Fig. 466.)

When it is necessary to mix a new solution, the required quantity of stock solution is syphoned into the tank, the contents of one of these vials is emptied into it, and the deed is done.

FIG. 466.

Timing the Development.—There are two methods of timing the development of films. The one by sight, the other by the clock.

Development by Sight.—There are two methods of developing by sight. The one in which the film is watched from first to last, and is then placed in the fixer when the operator considers it has been sufficiently developed. The other, a method known as the "factorial" method. Both of these methods are unsatisfactory and out of date, so no space will be allotted them.

Clock Development.—When a film, which has been *correctly* exposed, is placed in a certain developing solution, which is maintained at the proper temperature, there is a certain given time for its immersion in that individual developer formula in which the best results for producing the image are obtained. Once that given time is determined for a certain formula, then all such films should be developed in it by the clock for that length of time—no more, no less.

Theory Versus Facts.—That is science; that is theory; and it all "rings well." The only real drawback to it is that it does not work out in the every day practice of an ordinary operator like myself, and for a perfectly good reason. Now just follow me closely for a moment.

1. Sixty-six degrees, it is stated, is the best temperature for the developing solutions. That is all right. It is possible for our solutions to be always maintained at that degree.

2. Developing solutions should be fresh. That is easy, too. They always shall be fresh.

3. Forty-five seconds is the exact length of time for bringing out the best results on the film. Again, this is easy. The Victor timer makes that possible.

4. Forty-five seconds—no more, no less—are required to properly develop a *properly exposed* film. Now there is the proverbial "Nigger in the wood-pile." *Properly exposed films.*

So we see that, while the films can always be developed for forty-five seconds, in fresh solutions, at a temperature of 66°, it is not possible, as has already been explained, to give the films uniform exposures, and that is where this theory of time developing does not always work out in practice.

Then, what is to be done about it? I cannot tell you what other writers do about it, because no one has thus far (as far as I know) given *his* secret away, but I will tell you what I do:

A set of pictures is taken and one film from each packet is developed just forty-five seconds.

As a rule, all of these pictures are satisfactory for diagnostic purposes, but again, as a rule, they are not uniform. Some were slightly over-exposed, while some possibly were slightly under-exposed.

Now, if it is desired, for *some special purpose*, to improve the appearance of this set, then the films that are a little too dark are *reduced*, and the undeveloped duplicates of those that are a little too thin are developed slightly overtime, and possibly in this manner a more uniform set of pictures may be produced.

However, it must be distinctly understood that while these *thin films* have been somewhat improved, they will not be equal, in reading qualities, to those films which were correctly exposed and developed the regular time of forty-five seconds.

Taking it all in all, right to-day, I find the taking of *satisfactory* dental skiagraphs a most difficult problem, the difficulty hinging upon the word "satisfactory."

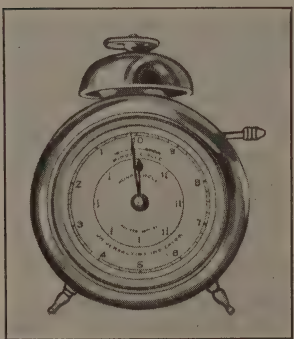


FIG. 467.

The Victor Timer.—This is a clock like arrangement which can be *set to ring* at any instant from twenty seconds up to two hours. No dark room can possibly be called complete without a Victor timer, or something equally as good—if such there is. (Fig. 467.)

Temperature.—The *correct* development of films can only take place in solutions of a temperature ranging from 65 to 68° F. *Bear that in mind always.* One can get results of course, if the solutions are 55° or even 75°, but they will not be satisfactory results after all.

If the temperature is below 55°, then the film will be what is called "thin," and so transparent that no details can be seen. When the temperature of the developer is at 75° or more, then the result is a dark film with the details obscure.

These four films were placed in one packet, and, therefore, all exposed simultaneously. (Fig. 468.)

No. 1 was developed in a solution at a temperature of 50°.

No. 2 was developed in a solution at a temperature of 60°.

No. 3 was developed in a solution at a temperature of 70°.

No. 4 was developed in a solution at a temperature of 80°.

Had they all been developed at one time in the same solution, they would all have come out alike. Thus is demonstrated the effect of the temperature of the solutions upon the result of the development.

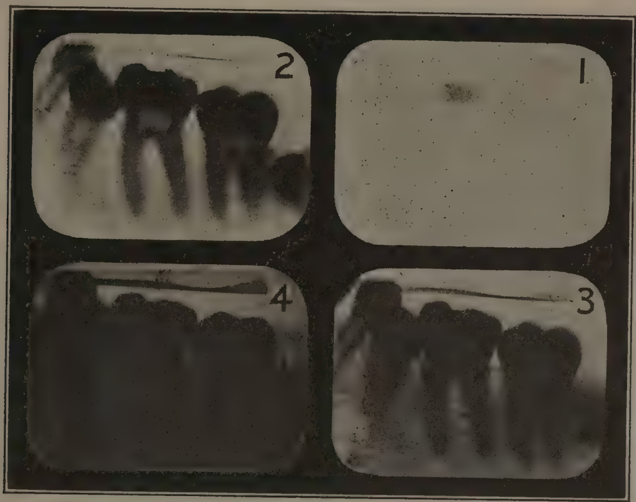


FIG. 468.

In my own case, the tap water varies from 55° in winter to 85 or more in summer, and when the tap water, which is used for washing the films, gets to 80° or more, then, unless extra precautions have been taken, as already described, the emulsion will be washed off of the film. Thus it is seen that the temperature of the solutions and of the tap water, as well, does play a very important part in the work.

Methods of Development.—There are two methods of development. The one, tray development; the other, tank development. The tank method is practically the only method used for X-ray work today.

In the early days, all photographers developed their plates and films in trays, and, naturally, I did the same. This was most unsatisfactory and so, in the early nineties, it occurred to me to use *tanks* instead of trays. In 1903, at the Ashville meeting of the N. D. A., I showed this tank system.

In the beginning I used a small porcelain jar which was immersed in a water bath—cold water in summer, warm water in winter.

The Developing Unit.—From time to time, various changes were made in this apparatus, until finally, what I call a "Developing Unit" was evolved.

In Fig. 469 is shown this unit. It consists of a water bath, in which are immersed three lead tanks, one each for the developing, hardening, and fixing solutions.

The Water Bath.—This is a copper or galvanized iron box, without a cover, as each tank is provided with its own cover. There is a hole in one end near the bottom for emptying the box, and this is closed with an ordinary cork. There are also several ½ inch holes in the end, about 3¾ inches from the bottom, and therefore, the water cannot stand in the box above this level. In one corner is soldered a piece of perforated brass tubing, in which the thermometer stands.

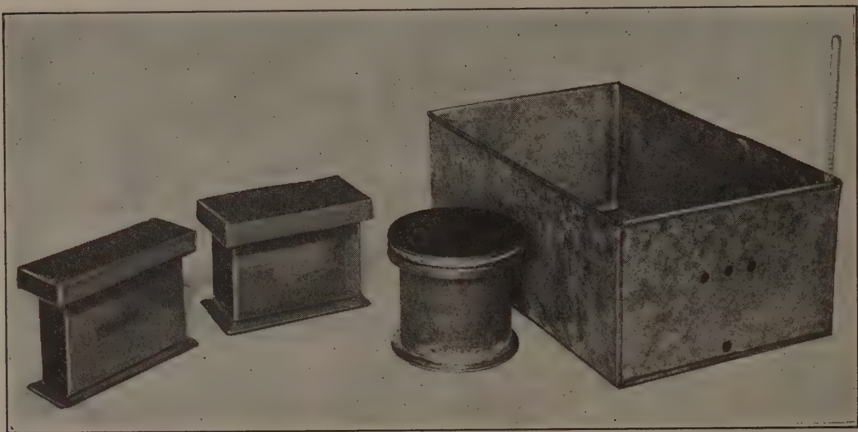


Fig. 469.

The temperature of the water bath was kept as near to 66° as possible by the addition of *ice water or ice*, from time to time, during the day.

Tanks.—While neither brass, tin, aluminum nor galvanized iron tanks will answer for holding the solutions used, on account of their chemical action upon these metals, I found that none of the solutions would act upon lead, which was most fortunate, as this metal is about the easiest of all to work. Any dentist can make up such tanks of a size to suit his own individual requirements, just as I have done.

The lead used is the ordinary sheet lead, that can be obtained from any metal supply house or sheet metal worker, and is known as "four pound lead."

Tanks may be easily and quickly made in the following manner:

Let us suppose a tank six by two, by four and a half inches deep is required:

1. Procure a piece of sheet lead of the following size: sixteen and one fourth by five inches, and another piece six and one half by two and one half inches.

2. Lay them out perfectly flat and even.

3. Procure a wooden block, cut nice and true, just six by two by eighteen inches long.

4. Lay the block upon the long sheet of lead, one half inch from a long edge.

5. Bend this one half inch over upon the rest of the sheet and hammer it down good and flat. This makes a half inch "bead."

6. Bevel the two ends of the sheet of lead.

7. Wrap it around the block and square all corners and bring the bevelled ends together and solder. ("Bead" outside.)

8. Stand on the smaller piece of lead, double edge uppermost, and solder. Thus a nice oblong tank is quickly and inexpensively made.

To Make a Cover.—Procure a piece of lead three fourths of an inch wide, and of the necessary length, and bend it to fit the *tank loosely*. Then lay it upon a suitable sheet of lead and solder, and solder the lapped joint at the same time.

To Make a Round Tank.—If a round tank is wanted, proceed as before with the sheets of lead cut to the sizes necessary, and then either get a cylinder of wood turned of the required size, or use a bottle or jar, (either will answer) and proceed just the same as when making an oblong tank.

Monell metal has recently come under observation, and I had a small tank made of this metal of about 26 B. & S. gauge, but, taking it all in all, I prefer the lead tank. Of course brass can be used and the tanks nickle plated, but that is more complicated and no better than the lead.

Shape of the Tanks.—The tanks are made of different sizes and shapes for two reasons. In the first place, developer is quickly spoiled when left open to the air; consequently, the developing tank is made as small as is suitable to the work in hand and thus the developing solution is economized.

In the second place, the tanks, being dissimilar, cannot get mixed, and a solution poured into the wrong tank.

The developing solution is always put in the small tank, the hardener in the round tank and the fixing bath in the larger tank. The hardening solution and acid fixing bath do not deteriorate by being exposed to the air, so it is better to have them in the larger tanks.

However, these two solutions—hardener and fixer—become exhausted by use, so when one finds that his fixer is getting "slow," he knows it should be renewed.

I know of no method of telling when the hardener becomes exhausted, so we change this on general principles just as often as we do the fixer, and this appears to be a safe rule.

Glass Tanks.—A small glass tank, and a most desirable one as well, can be readily made as follows:

Procure an amber or dark blue bottle of the desired diameter, cut a piece of paper four and a half inches wide and long enough to go around the bottle and paste this on the bottle. Take a one half inch knife edged carborundum stone in the engine, or, what is better, a larger one on the lathe, and grind the bottle gradually all around the edge of the paper. This ensures a straight cut. When cut through, smooth the edges with fine carborundum stones and sandpaper discs, and graduate, and a very nice developing tank is the result.

As far as I know, there are no *satisfactory* small tanks upon the market, so it is fortunate that very good tanks can be so easily made by any one and just to suit his own individual requirements.

Float Cover.—As the fixer and hardener do not oxidize when exposed to the air, lead (light and dust proof) covers, for these tanks are all that are necessary. (Fig. 469.)

The developer, however, does oxidize, consequently a lead cover will not prevent the air (between the cover and the solution) from acting upon it.

To overcome this, I devised paraffin float covers for the developing tanks, and they preserve the solutions very satisfactorily.

To Make a Float Cover.—Place the tank in a saucepan of water and heat. Place enough of ordinary paraffin in the tank so that when melted it will form a layer about one quarter of an inch thick in the bottom of the tank. When melted, remove the tank from the hot water and set it in a place to cool. When good and cold, place it back in the hot water again for a few seconds, or until the paraffin loosens, whereupon quickly turn it out into cold water.

Cut a piece of paraffin about one-half inch square and a quarter of an inch thick and attach it to the center of the disc by means of a hot spatula. You now have a suitable float for the tank. (Fig. 470.)

A cover for the tank can be quickly made of modeling compound, and it answers just as well as lead. Such a cover is also shown.

To make a Modeling Compound Tank Cover.—Proceed as follows: Soften a sufficient quantity of modeling compound and flatten it out good and even upon a glass or marble slab. Make it about one quarter

of an inch thick and while still soft, turn the tank upside down and sink its edges in it to a depth of about one eighth of an inch. Chill. Trim away all excess until it is nice and flush with the side of the tank. Form a little knob of soft compound and stick it to the center of the top, and you have a nice and light and very satisfactory cover for your tank, and one which is preferred to a lead cover for a glass tank.

A Good Test.—Pour, say, two ounces of the prepared developing solution into a clear glass tumbler, and cover it with a piece of cardboard, or sheet of glass, and place upon a shelf in the laboratory.

Pour two ounces of the same developer in a colored glass or a lead tank, and put on the paraffin float and then the lead cover, and place this alongside of the other solution.

FIG. 470.—Glass tank made from brown bottle. Paraffin float cover and modeling compound tank cover.

Examine these two solutions at the end of forty-eight hours, and the one in the glass tumbler will be found badly discolored, while the contents of the covered tank will be just about as clear as when placed therein.

Thus is clearly demonstrated the value of, or rather the necessity for, dark tanks and float covers.

Drying the Films.—After the films have been thoroughly washed, the next step is their proper drying. They can be slowly dried by being hung in a suitable place in the dark room, or more quickly dried by being hung in front of an electric fan, or by compressed air. The latter is the method of choice.

Dust is everywhere. An electric fan stirs up whatever dust there is, and is apt to deposit it upon the drying films, which is a great disadvantage. If one has a dust proof place, then the fan would be satisfactory.

The advantage of compressed air is that it is clean and cool and the method requires but little space.

Drying Box.—In Fig. 471 is shown a drying box, which, being only two inches deep, occupies but little space as it is secured to the wall. It is eight inches wide and twenty-four inches high, open top and bottom. Against the back is secured an ordinary piece of half inch mesh galvanized iron wire netting, which allows of the films being hung anywhere in the box.

Across the bottom of the box is a piece of ordinary one eighth inch gas pipe (galvanized iron) in which a row of holes has been drilled, the holes pointing upwards. This is connected to a compressed air supply, a valve and an *air filter* being inserted in the line.

The films are hung in this box, door closed, air turned on, and are thus rapidly dried while practically free from dust. Taking it all in all, this is a most satisfactory method of drying films.

Should it be necessary to call for the films of a certain patient while they are still wet, the assistant looks on the record book, notes the numbers of the clips as recorded, and picks them out of the drying box with ease.

Should they be dry, she puts them in a glass study mount for examination, all in a minimum of time on account of their identifying numbers.

FIG. 471.

Rapid Drying.—Glass plates and duplitized films may be rapidly dried by first immersing them in proof alcohol for five minutes, and then placing them before a fan or in a stream of compressed air.

The ordinary dental film, however, cannot be well dried in this manner, because it will curl upon drying.

In Fig. 472 is shown a dental film, thus dried, and also one which was clamped at each end to prevent its curling.

Metol.—Metol is a very popular developing agent, which is poisonous to some persons. Any one who uses metol and has any irritation appear upon his hands, which he cannot account for, had better consider this fact.

Photographic Prints.—There are times when prints must be made from the films.

Azo Glossy Printing Paper, as it is called, appears to be the best printing paper so far used. This can be obtained from any photographic supply house with full directions for its use, which are easily carried out.

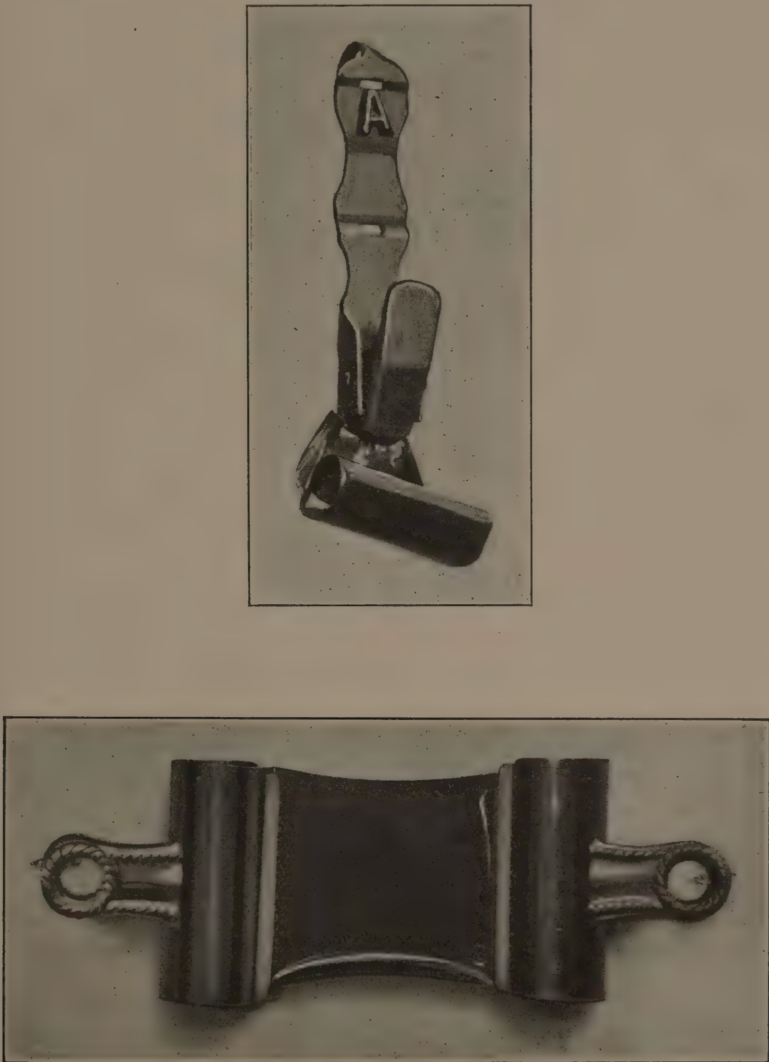


Fig. 472.

Such a print should always be squeegeed upon a ferrotype plate, as this makes a much better print than if it is dried in the usual way. Directions for this method can be had from the photo supply stores.

The Eastman Co. now furnishes an X-ray positive paper for making contact prints from films. This has only been used, by me, to a limited extent, but it appears to be very satisfactory.

Hypono.—Hypono is a rapid eliminator of hypo and is made by Marion & Co., of London, England.

Let us assume that, under ordinary circumstances, it requires twenty minutes for washing a film. If the film is taken from the hypo, rinsed, and immersed in Hypono for three minutes, then five minutes of washing under the tap is all that is necessary. Thus twelve minutes are saved by the use of Hypono under those circumstances.

Constant Temperature Baths.—While this developing unit, with its home made tanks, was far and away the most satisfactory developing apparatus so far used, still the fact remained that one could not go into the dark room upon the spur of the moment and find the solutions at the exact temperature desired. A little time would usually be required to bring them to the correct temperature by the use of ice, and time is the most important item in a dental practice.

It then occurred to me that if the temperature of the bath could be *automatically maintained* at 65 or 66° a wonderful improvement would result. In order to accomplish this purpose, one must:

1. Furnish a constant supply of water below 65° in temperature to the water bath, and

2. Automatically raise the temperature of the water bath to about 66° and maintain it there.

Once this problem presented itself in this abstract form, its solution was easy.

1. In order to supply the water bath with a constant supply of cold water, a wooden box, with a galvanized iron lining, was procured, and upon the bottom of the box was laid a coil of three sixteenths soft copper tubing, about five feet of the tubing being used in the coil. (Possibly seven or eight feet would be better.)

This tubing entered and came out of the box at a point near the top. One end of the coil was connected to the water supply, which was controlled by a globe valve; the other end was arranged so that the water from it would drip down into the water bath.

Upon placing a block of ice in the box, putting on the cover, and opening the valve, a stream of cold water flows out of the other end of the tube. Thus the problem of the cold water supply was settled.

2. A pencil thermostat was procured from the Central Scientific Co. (Chicago) and was connected to an eight candle power red bulb, and both were partly immersed in the water bath. Thus was the question of the automatic control disposed of.

How It Operates.—The first thing in the morning, a block of ice is placed in the ice box, and water turned through the coil so that it flows from the other end, a rapid drop by drop—a stream is not necessary. Then some ice is placed in the water bath itself, and that is quickly brought down to 66°, whereupon the ice is removed, if there is any left, and that ends the matter for the day, the thermostat having been originally set for 66°.

The flow of the cold water soon reduces the temperature of the bath slightly below sixty-six, whereupon the thermostat immediately gets into action and closes the circuit. The electric lamp immediately flares up, the glass bulb at once gets warm, and in a moment or two the water in the bath is raised slightly above sixty-six, whereupon the thermostat opens the circuit and the lamp goes out. And so on all day long. Every little while the lamp flares up and then goes out—and there you are. The water bath and the solutions therein are maintained at practically 66° all day long.

While this makes a very reliable bath indeed, it was found that the thermostat is hardly necessary. It is a very easy matter to regulate the flow of the iced water so accurately that the water bath will hardly vary a degree in hours, but, of course, it will vary some, which it will not do when the thermostat is used.

This was only designed this summer, and really is not completed. The ice box and the water bath itself should be covered with about two inches of some cork insulating material, which will be done before another season.

However, roughly made as it is, its operation is most satisfactory. The solutions are maintained at about 66°, not varying more than half a degree either way just as long as there is any ice in the ice box.

From time immemorial, the development problem, in summer, has been a most vexatious one to me, and every year numerous films would be spoiled in one way or another, and when they were not spoiled entirely, some would be too light and others too dark; few just right—but all this appears to be a thing of the past. This "Wonder" developer and the *constant temperature bath* have solved the problem, as far as I am concerned.

Timing the Exposures.—The correct timing of all exposures is of the greatest importance.

Some machines are equipped with automatic timing switches. These are set for the desired length of time, the switch is closed, and when the time is up, the switch is automatically opened.

Such a switch is, of course, ideal. My machine was not equipped with such an automatic timer, and so, when I installed it, I continued to expose by counting as I had always done previously.

When one becomes accustomed to this, it is surprising how accurately one can count off the seconds. As the word "George" is said, the switch is thrown in; Washington one, George Washington two, George Washington three, and then, as the word "*three*" is finished, the switch is opened, and a three second exposure, almost to a dot, has been given.

Quite recently I installed an "Eastman Timer" as shown in Fig. 473 which may be a slight improvement upon the counting, but not much.

FIG. 473.

In the taking of dental skiagraphs, there are four factors to be considered:

1. Focal distance—that is, distance between the cathode and the tube.
2. Length of exposure.
3. Character of the ray, and
4. Radiability of the subject.

Of these four factors, one and two are absolutely under control, and the other two are not, and that is what makes it interesting.

The length of time necessary to properly expose a given film depends upon the other three factors, and, therefore, this element of time must be absolutely a question of judgment of the operator himself. No set rule can be laid down.

With the focal distance always the same, and the current as nearly as uniform as the machine will permit, then the time must be changed according to the radiability of the area to be skiagraphed.

The Mayo's Chart.—At the Mayo's they base the time of exposure upon the weight of the patient, and here is their table:

MAYO EXPOSURE TABLE

	Extra light	Light	Medium	Heavy	Extra heavy
Upper molars	6	7	8	9	10
Upper bicuspids and cuspids	2	3	4	5	6
Incisors	3	4	5	6	7
Lower molars	2	3	4	5	6
Lower bicuspids and cuspids	1	2	3	4	5
Lower incisors	1	2	3	4	5

The figures denote seconds, but the millis used do not appear upon the table, and they, of course, must be considered, as also the focal distance. It is thus seen that ten skiagraphs are considered necessary for a "full mouth examination" at the Mayo's.

This exposure table, plausible as it appears at first sight, will not stand analysis, nor will it work out in practice, and for the reason that there is no direct ratio between the weight of a subject and the radiability of his jaw. For example:

A man comes in today; he is tall, thin-faced and under weight, and weighs, let us say, one hundred and forty pounds. He is immediately classified as light weight on Mayo's chart, which is all right.

A year later he returns—a very different man—weighing two hundred pounds, and with a full, round face, and so he is put in the extra heavy class and, consequently, the exposures given today, according to the Mayo Chart, are about fifty per cent more than they were a year ago.

As a matter of fact, while he had gained so much in weight, the thickness of the alveolus had not increased at all, and, though the super-imposed cheek had thickened and his face rounded out, the radiability of his jaws would be practically the same today as it was a year ago. It will thus be seen that he should have been put in the same class as before, irrespective of his weight.

Therefore, instead of considering the size and weight of the individual patient, I examine the *inside of the mouth only*, and base the length of the exposures upon the *thickness* of the alveolus, and this method is recommended to the consideration of the thoughtful.

With these two factors—the radiability of the parts, and the character of the rays—both unstable, it is readily seen that *judgment* is the governing factor as far as results are concerned.

Neither can I subscribe to the fact that there is a direct ratio of radiability between all of the teeth as indicated upon the Mayo's chart. Sometimes it is found that, due to the shape of the arch, it will require *nearly* as long an exposure for the upper central as it does for the upper molars.

The whole secret in getting a good picture is to give the film sufficient exposure. If the usual exposure does not produce the desired result, give it more.

Right now it is believed that in cases where only the best results can be accepted, either one of two courses must be pursued:

1. The taking of a skiagraph of a predetermined region (the same in every case) and developing that picture at once, and thus getting the "range" on the radiability of that individual, and then basing all the exposures of his mouth upon the results obtained on that film.

2. By over-exposing the films and then reducing them. (See page 594.)

By using either of these methods, it is believed that better results can be obtained than by the ordinary routine methods as recommended by others.

Penetration of X-ray.—It must be remembered that the penetration of the ray decreases inversely as to the *square* of the distance. For example, let us say that a three second exposure is ample for a certain picture with a ten inch focal distance. If, then, the focal distance is doubled and thus increased to twenty inches, the time of exposure must be quadrupled and thus increased to twelve seconds.

Recording the Exposure.—It having been shown that the taking of satisfactory dental skiagraphs is largely a matter of experience, then it becomes necessary for the student to keep a record (for future reference) of certain factors used in taking these pictures, and thus "get a line" on his work.

Take, for example, an ordinary routine case of root canal filling. A skiagraph is taken, three seconds exposure and twenty millis used. These two items are recorded, but not the focal distance, as that is always the same.

The root canal is opened and a diagnostic wire is inserted, and the case is ready to be rayed again. The former record is looked up, and if it is found that the skiagraph was satisfactory, then the second exposure would be given just the same—three and twenty.

But suppose the first film was a little over-exposed? Then this time the exposure would be shortened and the film given, say, two or two and a half seconds by twenty millis. Or, suppose, on the other hand, it was a little too light; then this time it would be increased to four by twenty, and so on all along the line. Every time a *repeat* is made, the former record is looked up and the operator governed thereby, and this is the only way that good results can be obtained.

Examples of Incorrect Exposures. (Fig. 474.)

Film No. 1 was exposed two seconds.
Film No. 2 was exposed four seconds.
Film No. 3 was exposed six seconds.
Film No. 4 was exposed eight seconds.

All were developed simultaneously. Thus is shown the effect of under-exposure and over-exposure.

Evidently five seconds would have been the correct exposure for that first molar.

Protecting Films.—The film, before and after exposure must be kept in lead-lined boxes, or, what is preferable, a lead-lined drawer in the cabinet. They must be surrounded upon all sides by lead or else they will be affected by the ray, even if they are kept in an adjoining room with an ordinary partition in between.

The Eastman Co. furnishes a convenient little wall safe for the protection of films (Fig. 475) which might be satisfactory to some operators.

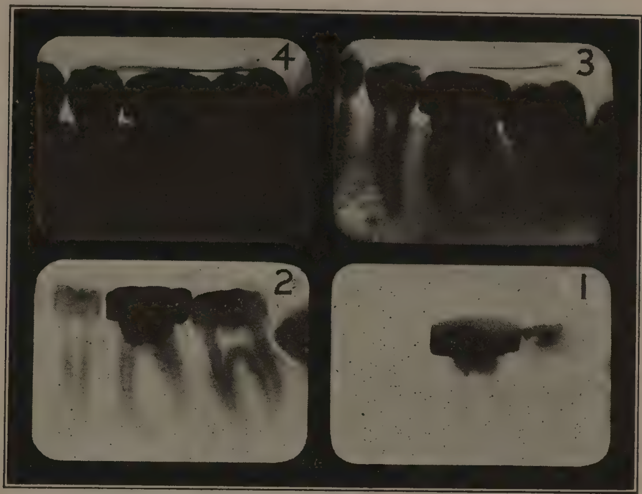


FIG. 474.

Personally, a good sized lead-lined drawer, where there is plenty of room for a good sized stock, is preferred.

Identifying Films During Development.—Once the film is exposed, it is necessary that one may be able to *identify* it from that moment on. This is accomplished in the following manner:

Eastman Clips.—Eastman clips are used for handling the films during development. As they come from the manufacturer, many of them are unsatisfactory because, in the haste of making, the little points that grasp the film are not made to register properly, and so the film is held at any and all angles instead of being held straight.

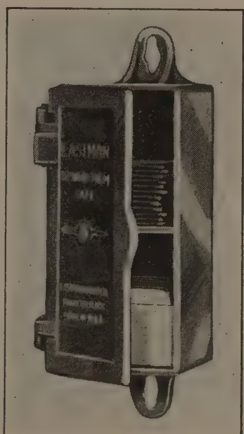


FIG. 475.

Therefore, the very first thing to do, when receiving a new lot of these clips, is to adjust these little points, with a pair of pliers, on all clips that need it.

The next thing to do is to number each clip, which can be done either by soldering on small lead numbers (which can be obtained from Besly & Co., 118 North Clinton St., Chicago, or any similar supply house) or by engraving these numbers on the clip by means of a No. 1 round bur in the engine handpiece. In Fig. 476 are

seen such clips. Number three is a lead number soldered on, while No. 12 was cut with the bur.

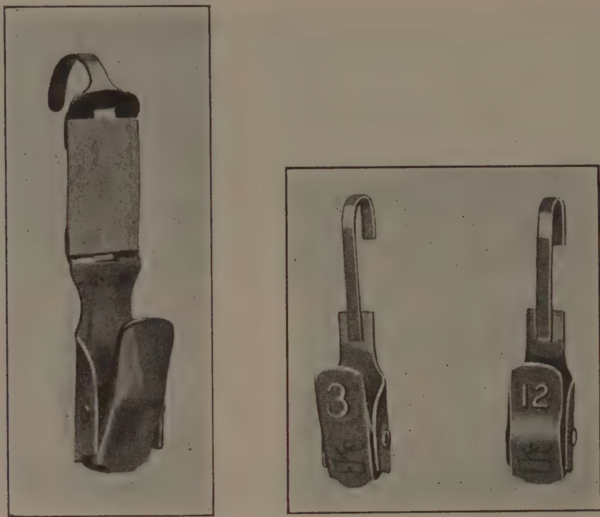


Fig. 476.

The Eastman Co. also furnishes another kind of clip, which is shown. This is provided with a celluloid blank upon which one may write, but I much prefer to permanently number the clips as shown.

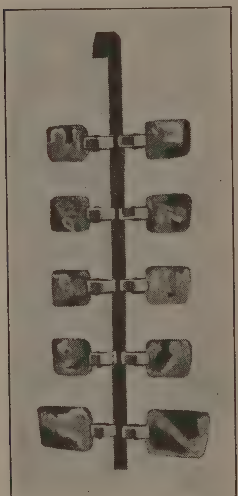


Fig. 477.

Gang Clips.—The Eastman Co. also furnishes a gang clip which carries ten films (shown in Fig. 477) but this is intended for a deep tank and, consequently, cannot be used in a shallow tank such as I use and advocate.

In Fig. 478 is shown a gang clip of my own design and home-made. This takes care of four films and hangs across the developing tank, and does not interfere with a cover being placed over it. In Fig. 479 is also shown another style of gang clip, which holds eight films.

Study Mounts.—For the examination and the study of films, they are placed between two plates of glass, which are hinged along one side by ordinary passe partout paper binding. The films are arranged in order, and the sheets of glass held together by a common clip, and thus they may be studied to the best advantage in order to make a diagnosis.

The advantage of these study mounts is that all sizes of films may be placed in them. The mount is tagged by an ordinary label, all as shown in Fig. 480.

Special Mounts.—The ordinary film mounts, as previously described, are practical only to a certain extent, as films of only one size can be mounted therein.

FIG. 478.

Upon the ordinary dental skiagraph, only about one third to one half of the picture is distinct, the balance being distorted, or, if not distorted, its detail at least is impaired. This applies to nearly all regions except that of the lower molars.

In viewing these films, the distorted or unsatisfactory details usually predominate and attract the eye, so that the general effect is not good.

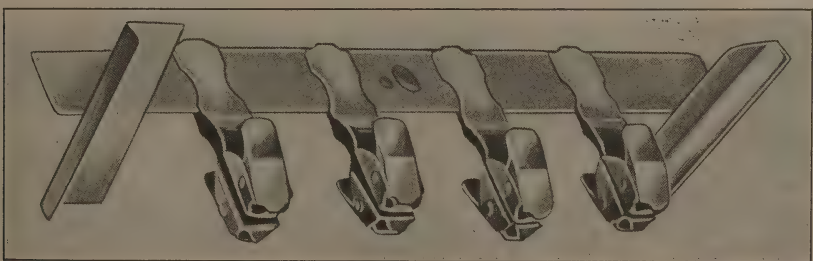


FIG. 479.

If all but the part of the film which is quite satisfactory is cut off, then that part of the film which is left presents a much better looking picture. If a set of films is so treated and then mounted between glass, and blocked off with black paper, a very much more satisfactory result is

obtained. This, of course, takes time, and is not practical for every day use, but upon special occasions this method is used.

An advantage of no little importance inherent to this method of mounting is the fact that larger films may be arranged along with the smaller ones, as shown in Fig. 481.

Mounting between Glass.—There is a trick about this worth knowing; that is, if one ever uses this method. None of the flat glass is *really flat.* It is all more or less concave. Old plates from which the emulsion has been washed off, which can be readily cut down to sizes to suit, or cover glasses from slides are used for this purpose. Now if the two concave surfaces are placed together (for, to repeat, they are not flat) it is not possible to hold the films between them in position; there being a space between the two glass plates, the films will slide all around. It is, therefore, necessary to first place the plates together, look at them edgewise, and reverse and repeat the process until you finally decide which are the convex surfaces, and then put these together, whereupon the films, being in contact with both glasses, will stay in place.

Improving Unsatisfactory Films.—If a film is unsatisfactory because it is too dense, it can be "reduced," and if because it is too thin, then (possibly) it may be "intensified."

Reduction.—If a film has been over-exposed, it cannot well be "doctored" by *under* development. It is best to develop it the full time, and then reduce it by means of the well known Farmer's formula. Stock solutions:

A

Water	16 ounces
Hypo	1 ounce

B

Water	16 ounces
Red Prussiate of Potassium	1 ounce

(B, being affected by the light, must be kept in amber bottles, or else, if in an ordinary bottle, it must be wrapped in black paper or kept in a light proof box.)

Mix for immediate use:

A—8 ounces
B—1 ounce

The film may be transferred from the fixing bath or washing tank to this solution, but if it has been dried, then it must first be soaked in water for twenty minutes or more.

Watch reduction closely, rinsing the film before holding it up for examination, and when it has reached the desired density, wash for fifteen or twenty minutes under the tap. This process of reduction is a most

easy and satisfactory one and should be carried out by subdued daylight or weak electric light. In Fig. 482 are shown two films. They were over-exposed simultaneously and one was reduced.

Right here should be recorded a very peculiar effect produced upon the film by this process of reduction, and one that I have never seen mentioned in any book, nor ever heard spoken of, but it is there all the same, and very annoying, to say the least, unless steps have been taken to counteract it.

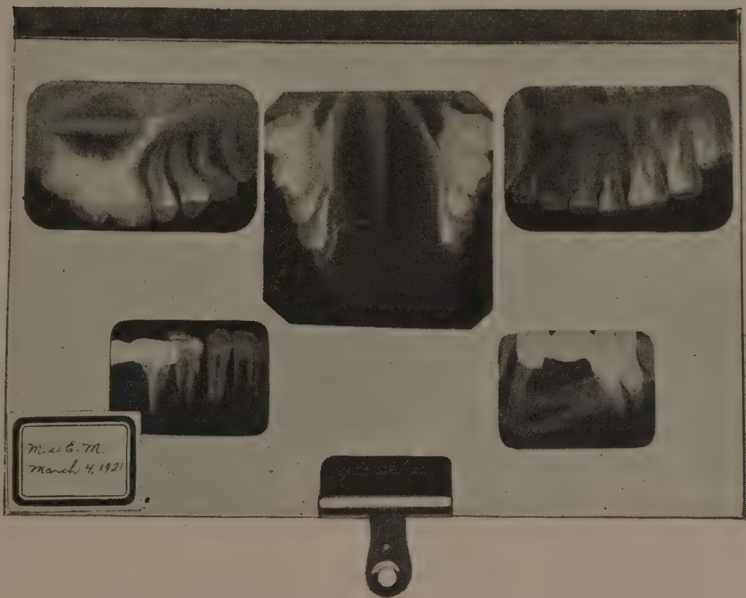


FIG. 480.—Three sizes of films quickly mounted for study.

As elsewhere stated, the ability to "locate" a film depends entirely upon the fact that the emulsion side has a *dull appearance*, while the reverse side is *glossy*.

Now it just happens that, after a film has been reduced, the emulsion surface has become just about as glossy as the reverse, and, consequently, they cannot be told apart. Thus the guide for the orientation of the film has been lost.

I have devised a very simple method for overcoming this difficulty. Before reducing a film, it is held right side up, emulsion nearest, and the right hand upper corner is clipped off. With this as a guide, the film can always be correctly placed for orientation.

Intensification.—If a film is under-exposed, I know of no way to appreciably improve it. "Intensification," as the process is called, has

never been very successful in my hands. The best way is to take the skiagraph over, if that is possible. However, if one wanted to try it, here is the method:

SOLUTION A

Mercury bichlorid	100 grains
Potassium bromid	100 grains
Water	5 ounces

SOLUTION B

Soda sulphite	½ ounce
Water	4 ounces.

After the film is finished—that is, fixed and washed—place it in solution A until it has become white all over. Rinse, and place in solution B and leave it there until it has become sufficiently dense. In case it is not satisfactory, soak for ten minutes and repeat the treatment.

If, in the first place, the film has been dried, then it should be soaked in water for from twenty to thirty minutes before placing it in the solution A.

Lantern Slides.—A lantern slide consists of a more or less transparent (positive) picture, made upon one sheet of glass and covered, for protection by another sheet, and the two sheets of glass are bound around the edges by strips of paper glued on. The slide measures three and one-fourth by four inches.

There are two methods of making lantern slides: one, the direct method, and two, the indirect.

The Direct Method.—The direct method is the best method for small dental films, and there are two methods of making these slides.

The one is to make a transparency, as it is called, by placing the film against the lantern slide plate (emulsion surfaces in contact) in an ordinary printing frame (Fig. 483) and exposing to light—either daylight or electric light. This is called "contact printing."

This is then developed, fixed, dried, bound together with ordinary passe partout paper binding, and the slide is made. The result of this process is that the *slide* reverses the details. Everything that appeared white upon the film will appear *dark* in such a slide. (Fig. 484.)

The other way, and a very easy one, is to use the film itself, as its size is well adapted to the purpose.

For this purpose, a film must not be as dense as it should be when it is best adapted for examination before transmitted light; consequently, if necessary, it must be reduced to the necessary density by the usual process of reduction. (Page 594.)

The film is then placed between two "cover glasses," (the glasses made for the purpose of covering slides) with a black paper mat cut to fit, in order to cut off all extraneous light. The two sheets of glass are then

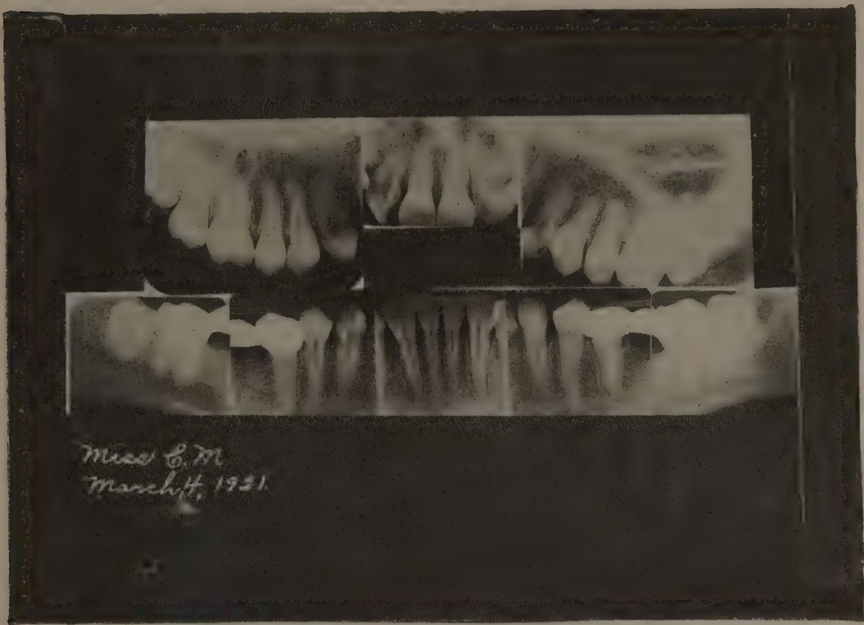


Fig. 481.—Films mounted between glass. (Both of these illustrations are photographs (*not prints*) of glass mounts, consequently, the details, as shown upon the films, cannot be brought out.)

bound with passe partout paper binding. A small sticker is put on a corner of all lantern slides for receiving its identifying mark or number. A slide

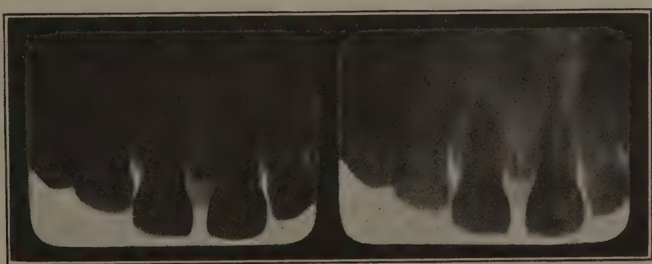


Fig. 482.

like this is shown in Fig. 485. The advantage of such a slide is that the picture thrown upon the screen shows all the details as one is accustomed to see them in the films.

This sticker is placed upon the lower left hand corner of the *back* of the slide when the slide is held in the proper position for examination. The lantern reverses the picture from side to side as well as vertically.

FIG. 483.

The Indirect Method.—This method, which produces the slide by a process of "printing by projection," is rather intricate and requires a photographic camera designed for the purpose. It is hardly necessary to describe the process or illustrate the apparatus in a chapter of this kind.

FIG. 484.

Lantern Slide Box.—A box specially adapted to the packing and transportation of lantern slides is shown in Fig. 486.

Orientation.—It is absolutely necessary that one should be able to determine whether a film represents the right or the left side of the mouth.

This is called "orientation." To do this, hold the film before the light, *emulsion side away* from you. You are then looking at the film from the inside of the jaw, and remembering that, it is very easy to place it.

FIG. 485.—This lantern slide is made up of two films. The one on the right taken with diagnostic wires in the root canals. The one on the left, the same tooth five years later.

Suppose it shows a bicuspid upon the extreme left, and then reading to the right, you distinguish a cuspid and a lateral; then you at once place the film as being of the left side.

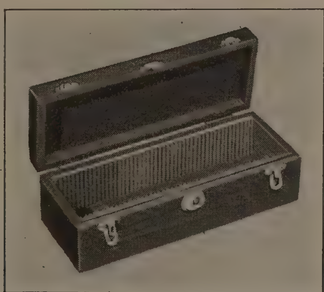
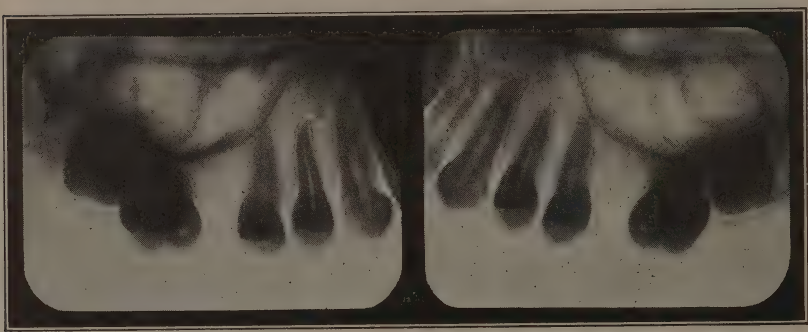


FIG. 486.

Suppose it shows, upon the extreme left, a bicuspid and then reading toward the right you see two molars in succession; you at once recognize it as a right-side film.

This is assuming that the film was positioned in the mouth with the emulsion surface *held against the teeth* when the picture was taken. With the Buck film and new Eastman small film packet, unless this is done, no pictures will be taken as the ray will not penetrate the lead backing in these packets.

However, in the Eastman paper enclosed films, it is easy to make a mistake, and carelessly reverse the film when placing it in the mouth, in which case no one could "locate" the skiagraph correctly by looking at it. In Fig. 487 at A is shown a film taken correctly, and at B one taken incorrectly, and one sees that they appear to be of opposite sides, while, as a matter of fact they are both of the same side, but one packet was placed in the mouth with the emulsion surface of the film away from the teeth, and, consequently, would be incorrectly localized if held in the usual way.



A *B*

Fig. 487.

Only recently a patient brought in a set of twelve films, and everyone was taken incorrectly. I say, "incorrectly taken" because it is universal practice to place the emulsion surface towards the tooth, and so when an operator does not do this, he does not take the pictures correctly.

Intensifying Screens.—An intensifying screen consists of a sheet of cardboard covered on one side by a layer of the finest grains of platinum-barium-cyanid. When this is enclosed with the film—the granular side in absolute contact with the emulsion surface—and exposed to the X-rays, the screen fluoresces, and thereby so greatly increases the action of the ray upon the emulsion that the length of exposure may be reduced by one-half or more of the length of time required to get the same result without it. The fact that the screen fluoresces for an instant of time after the current has been cut off from the tube, helps towards the result. While these screens are very useful in body and head work, they can

hardly be considered necessary for any work the ordinary dentist is called upon to do.

Making Dental Skiagraphs.—The present method for making skiagraphs will now be described. The work is naturally divided into several stages:

1. Posing the patient.
2. Making the record.
3. Developing the film.
4. Care of the finished skiagraph.

However, before proceeding, it might be well to list the accessories that must be at hand in the X-ray room.

1. Record book.
2. Developing clips either numbered or lettered.
3. Film holders.
4. Lead lined drawer or box for un-exposed films.
5. Lead lined drawer or box for exposed films.
6. Small envelopes.
7. Large envelopes.
8. Filing envelopes.

Posing the Patient.—This having already been described, it need not be considered again.

Making the Record.—For many reasons it is advisable, or, rather, it should be said, necessary, to keep a careful record of all exposures given to a patient. By this record, only, is it possible to improve one's technique. Again, this record might be necessary in order to secure protection from "sharks."

Imagine, if you will, one of these sharks, going to some X-ray operator, and being exposed over and over again, and then immediately going to some prominent dentist who would proceed to take some skiagraphs upon request. Then imagine, if you will, this person returning in a few days with his face burned as if from the rays, and charging the dentist with the damage and threatening a law suit. If he has no record of his exposures, he might stand for the blackmail, but upon his record, which he could produce in court, he might not have to "fall for the bluff."

The Record Book.—As the patient is being placed in the chair, his name is entered in the record book, along with the date and his *case number*, which is then given him unless he had previously been rayed, in which case, his old number is looked up, and then that is entered in the proper column in the book. (Fig. 488.)

Upon placing the film in the mouth, the region or tooth to be rayed is called out to the assistant and that is entered in the proper column.

When the exposure is made, the time, millis and button of the rheostat are also given her for recording.

At the same time, she takes a filing envelope which is an ordinary open end manilla envelope about three by five and a quarter inches in size, and upon it she writes the patient's name, the date and the case number. She also records upon it the region rayed, time and millis used.

AUGUST 1922

DATE	TOOTH	CLIP NUMBER	TIME M.A.	SPARK GAP	BUTTON	NAME	CASE NUMBER	REMARKS	ENTERED	FILED

Fig. 488.

Should the patient return at any future time for more pictures, these are immediately brought out, and thus a line gotten for the correct exposure of each region. In Fig. 489 is shown such an envelope.

The moment the film is exposed, one of the numbered clips (Fig. 476) is clamped to its edge, and its number is also entered in the book, and

thus the film can be identified all through the developing and drying processes.

Upon a small envelope the name of the patient and the date are written, and the film, with clip attached, is placed therein. If several films are taken for the same patient, then the envelope and all the films, with their clips attached, are placed in a larger envelope, where they stay all together until taken into the dark room for development.

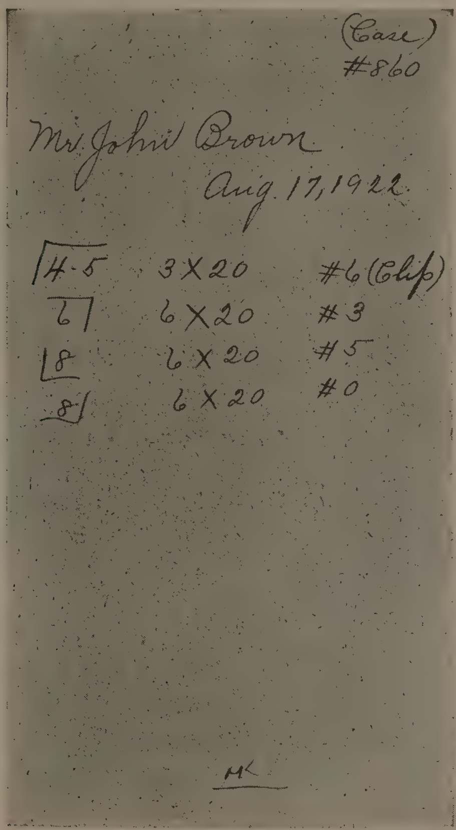


FIG. 489.

Only the skiagraphs taken for one patient are placed with their attached clips in this one envelope. (Fig. 490.)

Developing the Films.—When taken to the dark room for development, the films are placed in a box on the work shelf, right in front of the little window in the Wratten Safelight, and thus they can be plainly seen, and the little white envelope with the patient's name on it is laid along with them.

Before starting the development, the Victor Timer is *set* for forty-five seconds.

If, when beginning work in the dark room, the operator will close his eyes for a moment or two, upon opening them again, he will be able to "see things" much better than if he had not done so.

When handling films, one should be careful to touch the emulsion surface just as little as possible.

This surface can be identified before the safelight by its dull appearance, while the back of the film has a glossy surface.

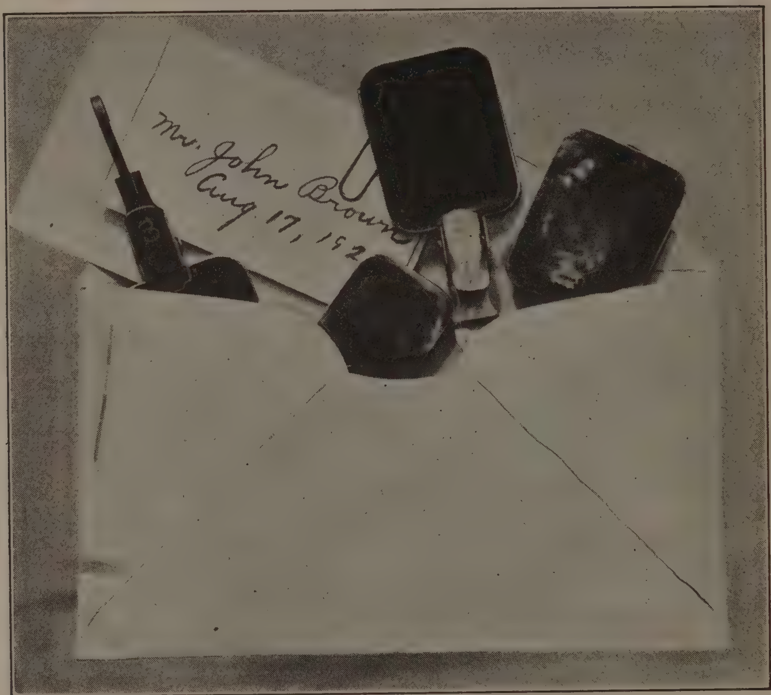


FIG. 490.

The film should be placed in the developing clip with the emulsion surface towards the front—that is, so that when the clip is hung on the edge of the tank, the emulsion surface is away from its side.

Upon opening each packet, one film is placed in its clip and laid in a dark place upon the shelf, and the duplicate is placed in its labeled white envelope.

As soon as four films have been opened, they are hung in the developer, giving each film a little *shake* in the solution, in order to free it of "air bells," and the *timer started.* The opening of other packets is continued while the first lot is being developed.

As soon as the timer rings, one developed film is taken in each hand, quickly rinsed, and hung in the hardener or fixer, according to the season of the year, and then the other two quickly follow.

Then four more are developed, while others are being opened and this is continued until all are put through.

The developing process (when this developer is used) is so short that no time is lost by this method, and it has the advantage of using individual numbered clips for the films.

However, if five minute developers were used, it would undoubtedly save time to use gang clips, already illustrated.

After all of the films are hung in the fixer, the timer is set, and the assistant can go off and attend to other duties.

Care of the Duplicate Film.—It is not considered good practice to develop both films at the same time, because every now and then something will happen and the film be spoiled, in which event, the duplicate film can be fallen back upon.

All duplicates are placed in the little envelope with the patient's name upon it (already described) and are filed in rotation in a light and ray-proof box, kept in the dark room for that purpose, and are, therefore, available if wanted. Once a month the contents of this box are transferred to another and a larger one where they are kept for a month or more, at the end of which time, if they have not been needed, they are destroyed. Should any one of these duplicates be wanted at any time (before it is destroyed) its envelope can be easily selected as the inscription upon it can be read by the Wratten green light.

Caution.—No matter how *safe* the dark room light may be, films should be exposed to it as little as possible. Film packets should be opened and the films handled some distance from the light.

"Fixing" the Film.—When time is pressing, after the film has been immersed in a fresh fixing solution for one minute, it can be examined by white light without injury, but this should be a hasty examination only.

The accepted rule for fixing a film is that it must remain in the fixing bath just twice as long as it takes to "clear" it. That is, if it requires three minutes for the film to be turned perfectly black all over, then the fixing time should be six minutes all told.

If films are not allowed to remain in the fixing bath for a sufficient length of time, they will not keep indefinitely, but become discolored and undecipherable in the course of a few months.

Washing the Film.—When the timer rings again, the assistant returns and hangs the films in the washing tank under the tap, sets the timer for fifteen minutes, and goes off again.

After the film is *fixed*, it must then be washed long enough to eliminate all of the hypo, because, if this is not thoroughly eliminated, in the course of a few months the film will become stained and undecipherable.

Washing under the tap for fifteen minutes is sufficient, but if there is no hurry, there can be no objection to allowing them to remain there longer.

When running water is not at hand, films should be hung in tanks of clear water for, say, thirty minutes, changing the water every five minutes.

Drying the Films.—Once again the timer rings, whereupon the films are taken from the washing tank, and each film is—or should be—wiped off with a piece of damp cotton, to remove "water marks" and then hung in the drying box. (Fig. 471.)

Thus it is seen that, by the use of the Victor Timer, each step can be carried on for just the necessary length of time, and the work completed within the minimum period necessary.

Every operator should be assured that he is washing his films long enough, to free them from "hypo," and this can be learned by making the following test:

Test for "Hypo:"
Make up the following solution:

Permanganate of potash	8 grains
Caustic soda	7 grains
Distilled water	8 ounces

To a small glass of distilled water, add four drops of this solution and stir well. This makes a solution of a delicate purple hue. Add to this a few drops of *fixer* and the solution will clear, or turn slightly green. This is merely to demonstrate the chemical reaction which takes place when hypo is added to the solution.

Now then, to make the hypo test. Fix a film as usual, and hang under the tap for five minutes, and then place it in the permanganate solution (four drops to a small tumbler of water—as above described) and wait about seven minutes. The purple solution will gradually turn light green, which shows that the hypo was not entirely eliminated by five minutes of washing. This test should then be repeated with a film that was washed ten minutes, and again with one that was washed fifteen minutes, if necessary.

When a film has been washed for a certain definite length of time, ten, fifteen or twenty minutes, whichever it may be, and then hung in the purple solution for ten minutes without any change in the color of this solution taking place, then one can be assured that no hypo remains in the emulsion and that thereafter all films washed that length of time *will keep.*

In my own case, ten minutes of washing was proven sufficient, but when time is not pressing, they are washed fifteen minutes, in order to "play safe."

Marking the Films.—After the films are dried, the assistant takes them one at a time, looks upon the record book in order to identify each film, and then marks it with pen and ink, with the case number found in the proper column on the book.

This is done *before* the film is removed from the clip, and, consequently, if at all careful, she can not possibly get the films mixed.

FIG. 491.

Once the film is thus numbered, its identity can never be lost. A hundred or a thousand such films can be thrown promiscuously in a box, and each one picked out and identified.

This method of marking the film was only conceived a comparatively short time ago, and it is the best method that I know of now. I only regret that it was not put in practice twenty-five years ago.

The case numbers are seen upon some of the illustrations. Turning to any one of these illustrations, by means of its number, it is possible to turn to the record book, and immediately learn for whom the film was taken, length of exposure given, number of millis, and the button used. Isn't that worth while?

Tagging Films.—After being numbered, each film is punched in a corner with a rubber dam punch, and then strung on a jeweler's tag, upon which is written the patient's name, and the date. In Fig. 491 is shown several sets of films, tagged in this way.

Filing Films.—After being duly tagged, they are placed in their filing envelope, which has already been prepared and described (Fig. 489) and filed away alphabetically in a drawer in the usual card index style.

Should a set be wanted for study at any time, the films are unstrung and arranged in a study mount, and the identifying tag slipped under the clamp which holds the two sheets of glass together.

Extra Oral Skiagraphs.—Skull pictures, as *usually seen*, are taken on eight by ten films or plates. This is all very well for hospital and labora-

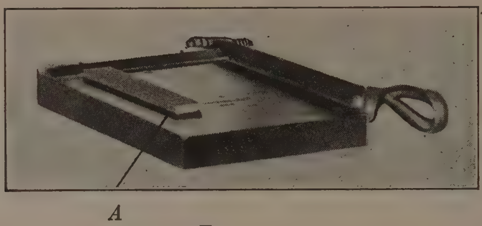


FIG. 492.

tory work, because such institutions are equipped for handling plates of that size or larger.

In a dental office, it is a different proposition, and as there is no need of using a film of that size, I use a small one.

A film three and a half inches square will cover the field that I want, so this is my standard size. Five by seven films are purchased and they are cut down upon an ordinary trimmer, as shown in (Fig.492.)

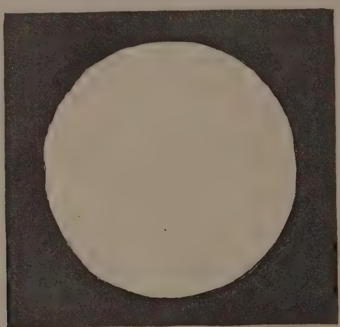


FIG. 493.

Upon this is seen fastened a guide strip at A. The film is laid up against this strip, and so is automatically and quickly cut to the exact size. They are enclosed in two black paper envelopes, or in an Eastman film holder, which has been reduced in size.

This size of film can be developed, etc., in the tanks used, and so their use does not necessitate any change in my apparatus or methods.

A piece of sheet lead three and a half inches square has its center cut out and is used as a *mat* when taking such pictures. This is laid between the patient and the film and gives the finished skiagraph a *frame* which sets it off to better advantage. (Fig. 493.)

Posing the Patient.—Posing the patient and focussing the tube require considerable skill when the *usual method* for taking such pictures is followed.

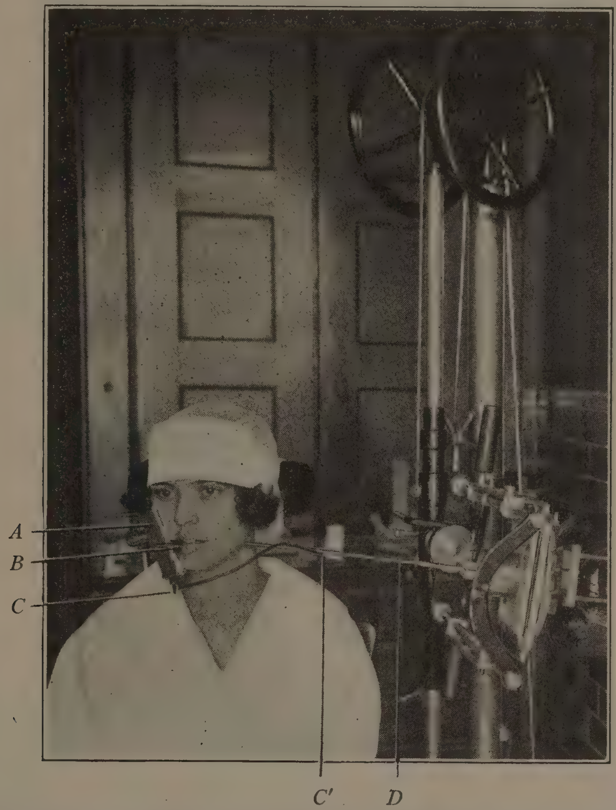


FIG. 494.—Posing the patient for an extra-oral picture (molar region) of the right side. (Bite guide shown in Fig. 495.) Cheek rests against the film holder *A*. *B* is the bite guide in the mouth. *C* and *C′*—the X-ray tube focussing guide. The tube is so adjusted that the dental pointer is exactly in line with the sliding rod *D*, and when that is done, it is in exactly the right position to focus the rays on the region set by the bite guide.

For some time I have been working upon an automatic posing appliance, and while it is not perfected, it is sufficiently satisfactory to warrant presenting here.

In Fig. 494 is seen a patient automatically posed by means of this apparatus.

To use the method, proceed as follows:

1. Take the bite guide shown in Fig. 495 and place a small ball of warmed modeling compound upon the end as shown.

2. Place this in the mouth of the patient with the compound over the lower tooth or *region upon which the rays are to be focussed*, with the flat bar lying upon the occlusal planes of the lower teeth, and have him close the teeth upon the bar. The cross-bar A must point toward the film. The softened compound is forced down around the teeth, and when it hardens it holds the bar in place.

3. Place the patient in the chair, with the cheek against the film holder, and while the teeth are firmly closed upon the guide plate, bring the point of the cross bar to the front edge of the film holder. See that the lower border of the jaw is parallel with the lower edge of the film holder.

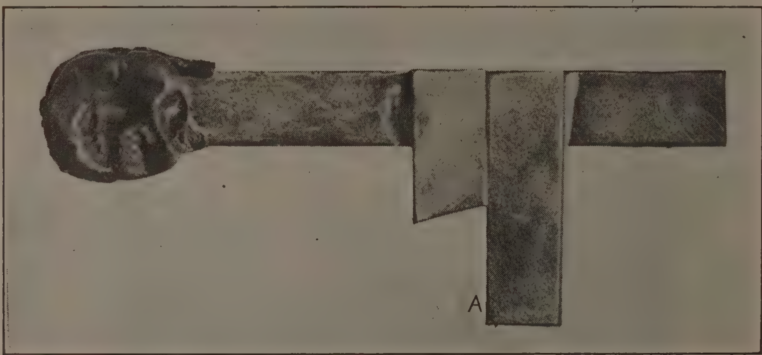


Fig. 495.

4. Adjust the tube focussing guide in position as shown.

5. Adjust the tube so that the pointer is exactly in the line with the focussing guide.

6. Place the film in position.

7. Remove the bite guide from the mouth, and also the focussing guide. Swing the pointer out of the way and snap the picture. (Fig. 496.) When using this apparatus, there are no angles to consider whatsoever. It matters not in what position the head is placed, the film holder and the focussing guide are automatically set at the correct angles.

It must be admitted that, year in and year out, I always had trouble taking skull pictures, while now with this simple apparatus, satisfactory results are easily obtained.

The cheek rest (film holder) is faced with lead one-sixteenth of an inch thick, as films should never be rayed when backed by *wood or brass.*

Duplicating Skiagraphs.—It is not claimed that, with this appliance, work can be duplicated. All that it does is to allow of the patient's being

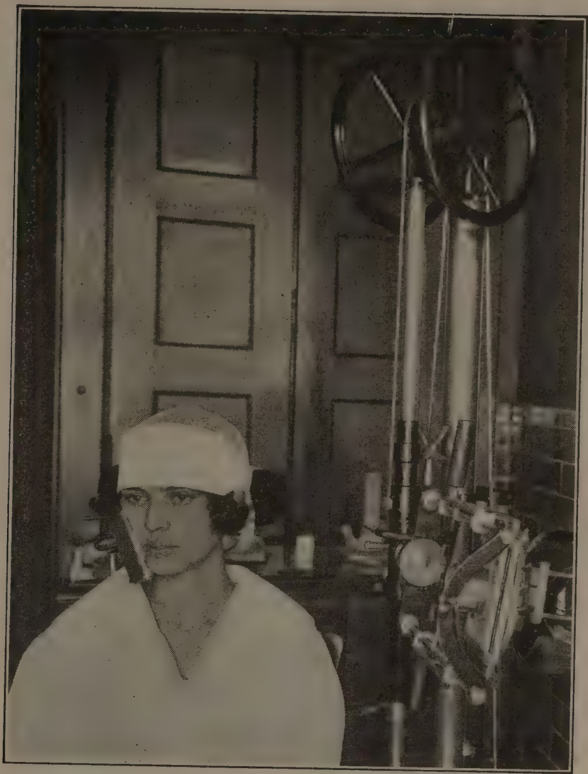


FIG. 496.—Patient automatically posed, focussing apparatus removed, and all ready to snap the picture.

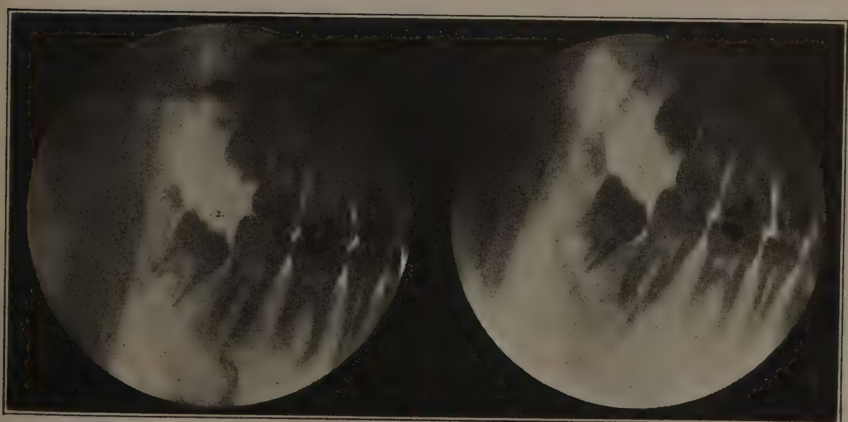


FIG. 497.—(Pictures reduced in size.)

quickly and easily posed so that satisfactory pictures are the rule and not the exception.

In Fig. 497 are shown two pictures (taken at separate sittings) of the same patient, and they show the possibilities of the method.

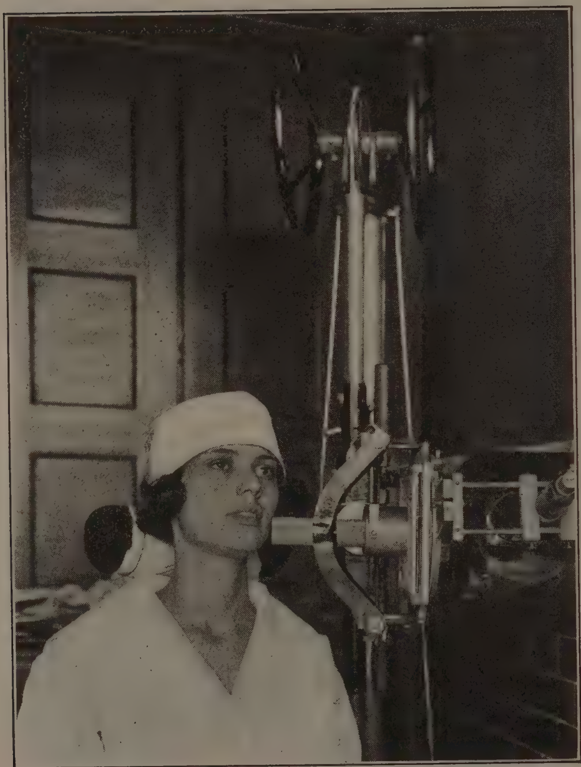


FIG. 498.—Exclusion tube in position.

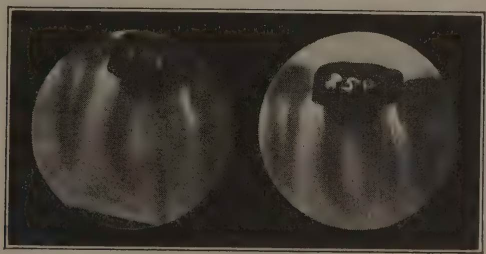
Scattered Radiation.—While the X-ray can neither be reflected nor refracted, there is such a phenomenon as "scattered radiation," by which is meant that when a beam of the ray penetrates, say for instance, the human

body, it will not come out upon the opposite side in the same shape and size as it was when it struck the near side of the body.

Naturally, this scattering of the rays impairs the efficiency in body work, and to overcome this, the "Buckey diaphragm" was invented, and compression cones were devised.

Exclusion Tube.—I did a great deal of experimentation along these lines in the early days, making up any number of "exclusion tubes," and I finally concluded that, in dental work, the parts penetrated by the ray are so comparatively thin that scattered radiation need not be considered. (Fig. 498.)

In Fig. 499 are shown two films, the one, A, taken with the lead "exclusion tube," and the other, B, with the usual aperture before the tube. No appreciable difference between the two films can be seen.



A *B*

FIG. 499.

Localizing Objects in the Jaw.—In Fig. 500 is seen a root fragment in the back part of an edentulous jaw. From a simple picture of this region, it would not be possible to place a lancet over the gum and strike down and be certain to hit the end of the root. The lancet really might be a quarter of an inch away, because there are no points to serve as a guide as to the location of the root.

Being rather conservative, and preferring to make a small wound rather than an unnecessarily large one, the following method is used in such cases:

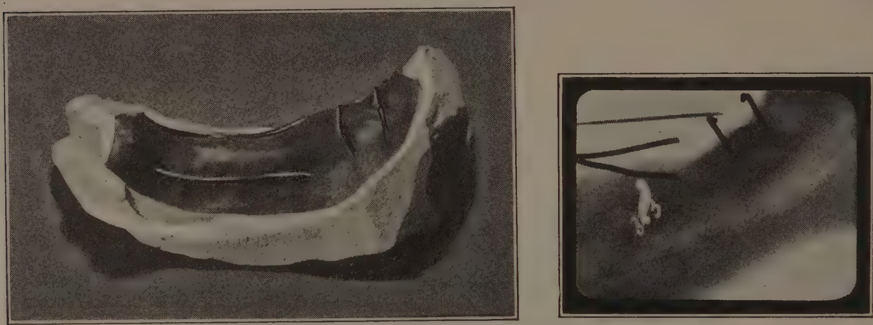
An impression is taken and a pink base plate wax form is fitted upon it as shown in Fig. 500 at A. In this wax are embedded several wires, and this form is then placed in position in the mouth and a skiagraph taken, the result being shown in Fig. 500 at B.

The wax is now cut off at the point where the root is seen. This is placed in the mouth, the gum dried at the end of the form, and the spot directly over the embedded root is touched with silver nitrate. This makes an indelible mark. The wax form is then removed, the parts anesthetised, the knife run down through the silver nitrate spot, and the root can be then quickly found, readily removed, and a small wound, which will quickly heal, will be the result.

At times it is possible to mould this base plate wax in the mouth, thus doing away with the taking of an impression and making a model.

Sometimes in attempting to remove a small root fragment, or even deeply embedded teeth, quite an area will be opened up, and yet this object cannot be seen or located.

In such cases, a gutta-percha point or piece of platinum wire is placed somewhere in the wound and a picture taken. Such pictures are invalu-



A B

Fig. 500.

able as they will give one a line on the position of the object that cannot be obtained in any other way, and thus is saved much unnecessary cutting of the bone.

In Fig. 501 is shown one of the most inaccessible third molars ever met with. This tooth was situated fully three-eighths of an inch distal to the second molar and very high up. Owing to the fold of the cheek, it

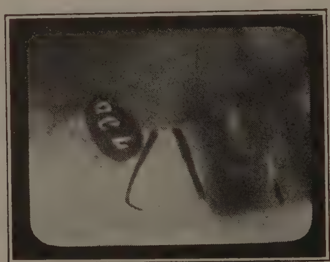


Fig. 501.

was hardly possible to see the operative field, and after chiselling away the bone and exploring the field, the tooth could not even be seen or located. Therefore, this picture was taken, and with it in view, the tooth was quickly and satisfactorily removed.

Radiopaque and Radiolucent Objects.—All metals usually found in the teeth are radiopaque, and, therefore, the *shadows* of gold and amalgam

fillings, gold crowns, posts, etc., appear in *white* upon the film. Gutta-percha, the oxy-chlorid and oxy-phosphate cements are also radiopaque. The silicate cement and porcelain are more or less radiolucent, and, when comparatively *thin*, *appear* in *black upon the film.*

Small discs of (1) gold (2) amalgam (3) gutta percha (4) oxy-phosphate (5) silicate were placed upon a film. With these were placed (6)

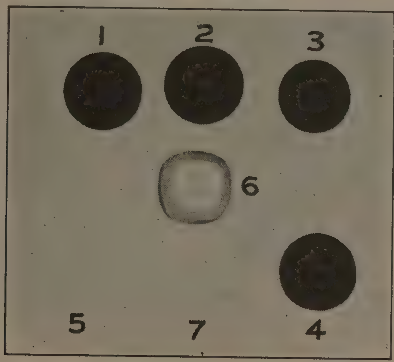


FIG. 502.

a disc of natural enamel, and (7) a Steele porcelain facing. They were all then simultaneously exposed to the ray, the resultant picture being shown in Fig. 502.

In Fig. 503 is shown a skiagraph of a central which contains two silicate fillings, one gutta-percha fiillng (lingual) and a gutta-percha point and cement root canal filling. The adjoining central contains an oxy-chlorid

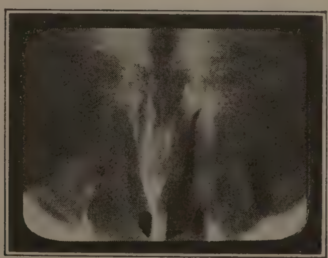


FIG. 503.

filling. The silicate fillings, which would show in black on the film, are white in the illustration. The gutta percha and oxy-chlorid, which would show in white on the film, are shown in black in the illustration. The dark shadow, shown under the silicate cement in the distal surface (to be seen on our right) of the central, represents an oxy-chlorid lining under the silicate filling.

The Dental X-ray Operator.—It is simply impossible to conduct a dental practice in a satisfactory manner to one's self, and with justice to the patient, without an X-ray machine at hand, but having a machine is not enough. Good pictures must be taken and intelligently interpreted.

No one is in a better position to do the very best class of dental X-ray work than a dentist.

No one should be more capable of intelligently taking such pictures for his own patients, and interpreting them correctly, than the dentist himself.

There are two classes of pictures produced in X-ray work.

1. Skiagraphs in which the grosser objects are plainly seen and can be interpreted by any one.

2. Skiagraphs showing finer detail and not so readily interpreted.

(1) Under this head would come all such objects as unerupted teeth, embedded root fragments, root canal work, and also skiagraphs disclosing the fact that certain teeth are missing; also those pictures which show the number and shape of the roots by means of which certain doubtful teeth may be identified as being either permanent or deciduous. It requires practically no experience to read such films.

(2) Under this head would come those pictures which are intended to disclose the finer lesions about the root ends which are caused by disease, such as incipient peridental inflammation, destruction of the lamina dura, condensing osteitis, rarefying osteitis, etc., and some of these periapical disturbances are so slight that they can readily be misinterpreted.

Here is where experience counts, and the best practical way in which to become proficient in interpreting such skiagraphs is for the student to study his films carefully, with a good reading glass, in front of a daylight bulb with a masked sheet of opal glass between. These are the very best conditions for the studying of films.

Root Canal Work.—It is safe to say that it is impossible to fill root canals satisfactorily without the aid of the ray to check up the work as it progresses and when finished.

What are called "diagnostic wires" are used in this work, and they afford the only practical means known for ascertaining the length of the root. I conceived the idea of using such wires in the early days, and am generally accredited with their introduction.

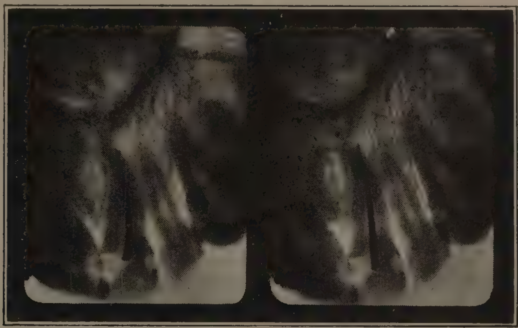
However, one must not imagine for a moment that a skiagraph will give, in every case, a *perfect picture* of the root end and its filling, but quite the contrary—such a picture is rarely exact.

If root ends were perfectly square, and pictures could be taken at exactly right angles to them, perfect results might be obtained, but, as it is, the foramen is often not at the very end of the root, and then the

result, as shown in the picture, depends upon the angle from which it was taken.

In Fig. 504 at A is shown an upper central with a diagnostic gutta-percha point in it. One would say that the point reaches just to the foramen and no further.

At B is seen another picture, of the same tooth, taken immediately



A *B*

Fig. 504.

after the one just shown, but from a different angle, and here we see the point protruding apparently a thirty-second of an inch.

As many as six pictures have been taken of a very troublesome case. The root canal would be filled and skiagraphed. The picture would show the filling either too *long* or too *short*. It would be removed, the canal refilled and another picture taken, and that was repeated until finally the filling appeared satisfactory.

Appreciating, as I do, the inherent weakness of all pictures of root end work, I can but smile whenever I see (as I have done more than once) an operator point to the picture of a root canal filling of *his* own, and hear him say it is a "classic" filling, or a "perfect root canal filling." Just another case of "where ignorance is bliss," etc., etc.

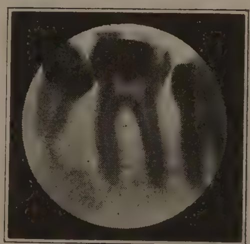


Fig. 505.

Differentiating Normal from Abnormal.—In Fig. 505 is shown what might be considered a rather satisfactory film. Here the root is completely and very clearly outlined by the dark line which represents the radiolucent peridental membrane. Outside of that is a clear white line which is the *shadow* (all *shadows* upon the film are *white*, one must remember) of the lamina dura, or "stratum durum" as it is sometimes called.

(Note. The illustration is the reverse of the film, and, therefore, the pericemental membrane is represented by the white line and the lamina dura by the dark line.)

Beyond and between the roots is seen the peculiar markings denoting the healthy trabeculæ of the alveolus.

Upon a good skiagraph, these three details—trabeculæ, lamina dura and peridental membrane—are easily recognized. When they cannot be seen, it is not a good skiagraph.

In order to interpret the picture of a suspected root, one must look for this lamina dura. If the outline of the root is not sufficiently clear to allow one to determine whether or not the lamina dura is there or has been impaired, then the picture is not good enough for a diagnosis, and another must be taken.

In Fig. 506 is shown a skiagraph of a lower molar with these two details effaced by disease.

Artefacts.—An artefact is a "product of an error or a reagent." If one discovers something upon a film that looks out of place and cannot be

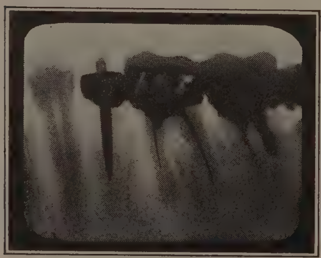


FIG. 506.

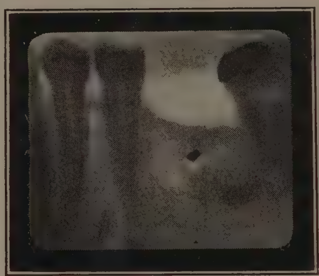


FIG. 507.

recognized, then its duplicate must be developed. If it does not appear upon this duplicate, it is recognized as an artefact. If it does appear upon the duplicate, then it is safe to take another skiagraph of the region before deciding what it is.

In Fig. 507 is shown a skiagraph taken in the regular routine work. The curious object, shown in the alveolus, was first considered an artefact. When it appeared upon a second film, it was proven to be a foreign object.

Interpretation of Skiagraphs.—For all practical purposes, skiagraphs may be considered to be shadow pictures, and, therefore, the relative positions, to each other, of the various objects which cast their shadows upon the film, can not always be determined by examining the film.

Here in Fig. 508 are shown two skiagraphs of a root and a wire, and both pictures look alike, and yet in one case the wire lay in the root canal, while in the other, the wire lay over the *outside* of the root.

As shadow pictures, they look alike, and yet they are skiagraphs of very different conditions.

In Fig. 509 is shown a picture of conditions frequently met with. Here we see a large radiolucent area apparently involving the apices of the roots of both the central and lateral, and any incompetent interpretor of films would undoubtedly say that the pulps of both teeth were "dead."

Now, in this particular case, the alveolar process was just one half inch thick along the line traversed by the ray. (I took the measurement.) The pulp in the lateral was perfectly normal (as it is today, over a year later) as the large abscess, which operative procedure proved this radiolucent area to represent, lay back of, and some distance away from, the root of the lateral.

This illustrates how careful one must be in *diagnosing shadow pictures*, and the pulp of any such tooth as this lateral must always be considered vital and healthy until *actually proven* otherwise.

FIG. 508.

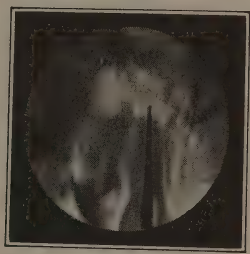


FIG. 509.

Pathology.—It is very unfortunate that pathology can not be recognized upon a film, and it is very much more unfortunate that many writers of note do not recognize this fact.

Before me, at this very moment, lies a copy of a recently issued text book upon this subject, from which the following quotation is taken: (Referring to a skiagraph) "Shows a dark shadow indicating periapical infection." It would be impossible to crowd more *mis-information* in so few words. And how unfortunate that one of the recognized leaders in this line should make such a statement!

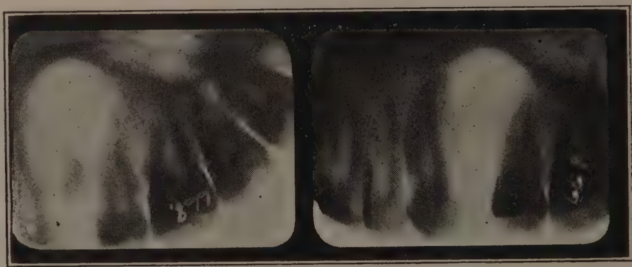
In the first place, the "dark shadow" to which he refers, happens to be the only spot upon the film upon which *no shadow* was cast. This "dark shadow" really did represent a hole in the bone—a decalcified area—through which the rays passed freely and, therefore, acted upon the emulsion to a great degree. So much for "the dark shadow."

Then he says: "This shadow indicates infection." No statement could possibly be farther from the facts. It indicates no infection at all. It indicates that the bone at that particular spot has been decalcified, and

that is all any such picture can indicate. To learn more about the case, a physical examination of the mouth is necessary and the history of the case must be known, or possibly other measures must be taken.

In Fig. 510 at A is shown a film upon which is seen a large radiolucent area. Upon operating upon this case, a large granuloma was found and removed. At B is shown another picture of the same case which was taken after the removal of the root and abscess. The radiolucent areas shown upon the two films are apparently alike, thus proving conclusively that the large abscess left no distinguishing imprint upon the film by means of which it could be recognized.

Possibly the most striking examples of the fact that the "dark shadow" does not indicate infection, as these men repeatedly say it does, are the pulp chambers and root canals, themselves.



A B

FIG. 510.

Every unfilled pulp chamber and root canal appear in black upon the film, whether or not the pulp is absolutely normal, or dead, or putrecent and teeming with billions of streptococci. They all cast "dark shadows," according to these writers. Every experienced Roentgenologist—to use the proper term for once—knows all of these facts only too well, and so it is beyond my comprehension how so many of them persist in making such misleading statements about these "shadows" and "infection." I trust that I have made this point clear, and that the illustrations used are convincing.

Time and again a patient has brought in a skiagraph saying, "Dr. So and So says that dark shadow there shows an abscess, and so the tooth must be extracted." I reply, "The Doctor was a little careless in the language used, because *he must know* that no skiagraph can show an abscess, and even if the tooth were abscessed, that does not necessarily mean that it must be extracted."

The patient (remembering the charge for the picture) at once flares up. "Then if the picture cannot show an abscess, what's the use of taking it?"

"While it is true that the picture itself cannot show whether or not the tooth is abscessed, a good picture, when taken in consideration with

a thorough examination, a physical examination of the mouth, and a history of the case as well, *may assist* a conservative dentist in reaching a correct diagnosis." And then I explain at length just how much a conservative operator can get out of a dental skiagraph.

Radiolucent Areas.—Radiolucent areas, that appear upon the film, may be normal and represent foramina or canals in the bone, or they may represent areas decalcified by disease, or from which roots have been extracted.

Disease itself can never be recognized upon a film—bear that in mind always.

There are found in a perfectly normal maxillary bone, the posterior palatine foramen, the anterior palatine foramen, the median suture and the antrum. The mental foramen and the inferior dental canal are found in the mandible. All of these are extremely radiolucent, and, when shown upon the film, can, under some circumstances, be mistaken for pathology by *incompetent operators*..

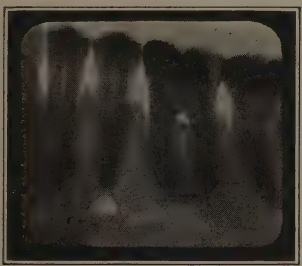


FIG. 511.

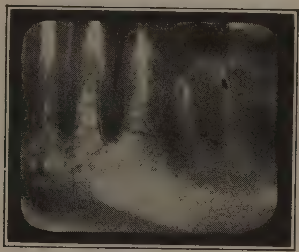


FIG. 512.

When one of these normal radiolucent spots falls upon the film at or near the end of a diseased or suspected root, then confusion exists, and it is only the careful and competent operator who can distinguish its possibilities. Here, in Fig. 511 is shown a skiagraph of a lower bicuspid, below the root of which is shown a radiolucent area. This is readily recognized as representing the mental foramen.

In Fig. 512 is seen another skiagraph of a lower bicuspid with the root canal partly filled and a radiolucent area at its apex. This picture, I am sure, would be interpreted by many an incompetent X-ray *diagnostician* as "indicating infection" as a result of a dead pulp and a bad root canal filling.

So far, so good. Now let's see what really did happen in the taking of these two pictures. An ordinary skull was first posed in such a manner that when a film was placed in the proper place, and the tube also *properly* positioned, the picture taken came out as already shown in Fig. 511.

Then the bicuspid was drilled into, the root canal partly filled, and then the skull and tube were so assembled that when the picture was taken, the radiolucent mental foramen *was thrown in line with the end of the root*, the resultant picture being shown in Fig. 512.

Just as I took this second picture purposely so as to throw that radiolucent area upon the end of the root, so have thousands of just such pictures been taken accidentally, and, as a consequence, perfectly normal mental foramina have been diagnosed as abscesses.

If the radiolucent area is caused by one of these normal anatomical elements, then the continuity of the peridental membrane and lamina dura is seen to be unbroken.

If there is or has recently been pathology at the end of the root, then there will be seen a break in the white line representing the lamina dura; thus is a normal antrum or some foramen recognized and not mistaken for an abscess.

In order to avoid making a mistake in such a case as this, two or more pictures must be taken of such a tooth. Therefore it is that one cannot be too careful when studying a film, and often pictures must be taken from one, two or three different angles in order to arrive at correct conclusions.

However, do not forget that pathology cannot be *recognized* upon the film, and that any radiolucent area, caused by pathological changes in the bone, may be, at the time the picture is taken, free from infection and on the road to recovery.

Shadows.—On the other hand, the malar *process* casts a dense shadow, which is more or less disturbing, and the coronoid process will, at times, cast a shadow upon the film in the region of the upper third molar, which again may be misunderstood by an inexperienced operator.

Clinical Results.—A patient comes in suffering from toothache. The tooth in question is sore, and there is a certain amount of inflammation about its root.

The pulp chamber is opened. The canal and apical area (?) are sterilized. The canal and part of pulp chamber are filled with an antiseptic root canal filling (cement). The patient obtains relief, and comfort follows.

Years go by—ten, twenty, thirty, and in one authentic case, that has recently come under observation, forty years—and yet the teeth remain comfortable and useful, and skiagraphs, then taken, show the apical areas to be in an apparently satisfactory condition.

Such clinical results, to be seen upon every hand, convince many conservative men that root canals can be filled satisfactorily; that abscessed teeth can be cured; that the present craze for extracting pulpless teeth is a crime, pure and simple.

Wounds in the mouth usually heal more quickly than they do in any other part of the body. A patient presents with an awful abscess upon a tooth. The tooth is extracted and in four hundred and ninety-nine cases out of five hundred of just such cases, nothing further need be done to effect a cure.

Any other joint in the body may become infected and cured, and yet these "one hundred per cent vital" men say that once the joint between a tooth root and the alveolus becomes infected, the infection can never be eradicated.

Such a statement must be absurd upon the very face of it. Clinical evidence—the most indisputable of all evidence—abundantly proves that root end infection can be eradicated and diseased teeth can be restored to normal, and no dentist is doing his duty to his patient if he does not at least try to save his teeth.

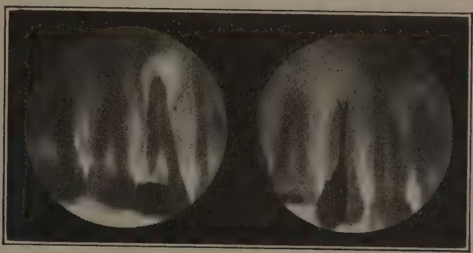


FIG. 513.

In Fig. 513 is shown a pair of films—"before and after"—of an interesting case. In October 1916, there was undoubtedly a granuloma at the apex of the first bicuspid root. Many gloomily disposed diagnosticians would look at this picture and say that, in view of the denudation of the root end for such a long distance below the apex, it would be considered a hopeless case, and the tooth should be extracted.

Before treatment, such cases never appear hopeless to me. These roots were filled at one sitting by the immediate root canal filling technic always employed.

The other film was taken in August 1922 and, to me, it shows that the infected area has been cleared up, and that the space, originally occupied by the granuloma, has been filled in with normal bone. The denuded root end has returned to normal, as shown by the peridental membrane and lamina dura upon the film.

The results accomplished in this case have been equaled in scores of other cases, and therefore it is that I believe clinical results prove that some abscessed teeth can be cured.

Oral Diagnosis.—Quite frequently an oral diagnostician will be called upon (usually, but not always, by an internist) for an oral diagnosis for some patient who suffers from some systemic disease. As a matter of fact, right to-day no internist can consider an examination complete in any such cases without an oral diagnosis being included. When such an examination is called for, naturally it must be thorough or it will be of no value.

To take skiagraphs for such a patient, find one or more *apparently* imperfectly filled root canals, and, on the face of such skiagraphs, advise the extraction of these teeth, is considered very bad practice.

Thousands of people who have one or more *apparently* partly filled root canals are going about absolutely well. On every hand skiagraphs are to be seen in which the root canal fillings *apparently* do not extend to the ends of the roots, and the apical areas appear absolutely normal and the people, themselves, have no signs of systemic trouble.

In Fig. 514 is shown a typical report as rendered by me.

Whenever a root canal is found apparently partly or well filled, and the apical area *appears* satisfactory, the advice is not to molest it, as I am not now, and never have been, a member of the one hundred per cent vitality club. Whenever a root canal is found *apparently* partly filled, and a radiolucent area at its apex, if the *tooth* is worth it, the advice is to attempt to remove the filling, sterilize the apical area and refill the root canal and keep it under observation.

Whenever the root canals of a multi-rooted tooth appear apparently well filled, and a radiolucent area is shown at its apex, the *extraction* of that tooth should be considered if the condition of the patient warrants it.

Whenever a *single rooted tooth appears* to have its root canal well filled, and a radiolucent area is shown about its apex, then *replanting* should be considered.

The consideration of any *doubtful* teeth is never advised unless the tonsils have either been removed or are pronounced to be in good condition by an *otologist of standing.* The diagnosis of tonsils by an ordinary physician *is never accepted by me.*

It must also be remembered that the sinuses, the gall bladder, the appendix, the prostate and other organs can be possible foci of infection. Don't forget that, and save the teeth whenever possible.

Skull Pictures.—In Fig. 515 is shown a skull picture in which a kind of a *radiolucent band* is seen to extend across the mandible, near the ramus. This dark area might be interpreted by an inexperienced operator as a break or some other abnormal condition, while, as a matter of fact, it is absolutely normal, but not readily explained.

ORAL DIAGNOSIS

OFFICE OF
DR. C. EDMUND KELLS
1237 MAISON BLANCHE
NEW ORLEANS

August 14, 1922.

Mr. John Smith,
New Orleans,
La.

Referred by Dr. Jones
For possible focal infection
For possible cause of reflex pain

Antra examined? No
Sinuses examined? "
Tonsils examined? "
Blood pressure? Not taken
Skiagraphs taken? No

History: Dr. Jones reports chronic myositis of lumbar muscles.

Condition of mouth:— Quite satisfactory.

Teeth require filling Nos. 2, 9, 10, 14, 17, 28 and 29.
Prophylaxis needed Yes.
Pyorrhea Practically none.
Faulty approximal contacts—Nos. 2 and 3 - 12 and 13.
Faulty occlusion—Nos. 3, 4, 18 and 30.
Evidence of periapical decalcification—Nos. None.
Root fragments—Nos.
Unerupted or impacted teeth—Nos.
Filled root canals apparently satisfactory—Nos. 7.
Filled root canals apparently unsatisfactory—Nos. 5 and 18 - but no radiolucent areas.
Root canals to be filled—Nos. 9 and 10.
Root canals to be refilled—Nos.
Extractions indicated—Nos.
Doubtful teeth to be observed and re-rayed later on—Nos.

Treatment Suggested:— As the skiagraphs disclose no decalcified areas about the root ends of any of the pulpless teeth, I believe the teeth can be safely eliminated from consideration for the present, at least; and the tonsils. sinuses and all other possible foci should be thoroughly examined.

The gold crowns do not fit - they rarely ever do - and, of course, there are pockets at their gum margins, in which debris can lodge and decompose. This is not serious. The crowns should be removed and new ones made.

If all other possible causes are eliminated without the real cause being found, then Nos. 5 and 18 should be reconsidered, and possibly an attempt made to fill their root canals to their ends. Only as a last resort should any teeth be extracted.

C. Edmund Kells.

Later. Dr. L—— reports the right antrum slightly affected.

FIG. 514.

When taking such a picture of a normal jaw, the tube happens to be so focussed that its central rays pass through the radiolucent larynx and pharynx, while the rays upon either side of the central rays encounter dense tissues all the way.

The result is that the rays passing through the dense parts are greatly intercepted, and make but a faint impression upon the plate or film, while the rays which happen to pass through the larynx and pharynx are strong enough to penetrate the mandible and cause the narrow band of radiolucency.

FIG. 517.

Is this clear? Well, its the correct explanation anyway, and so it is that when diagnosing such a picture, the operator must be exceptionally careful or he may go wrong.

Skiagraphs of Interest.—In Fig. 516 is shown the skiagraph of an upper central, the history of which sounds like a fairy tale. While a little boy was playing ball, this tooth was knocked out, whereupon the little fellow and several of his companions scampered home (only a short distance away) to his mother.

She at once sent his friends back to the scene of the accident to look for the tooth, which they found and brought to her.

She found the tooth intact, whereupon she rinsed it off under the tap and replanted it firmly in its original position; and it soon became as firm

as it ever was, and one year later, when this picture was taken, it had not changed color.

The apical area, as shown in the picture, is apparently normal, but the pulp chamber and canal have become greatly constricted. The root canal of the adjoining lateral also appears constricted—wonder what happened to it?

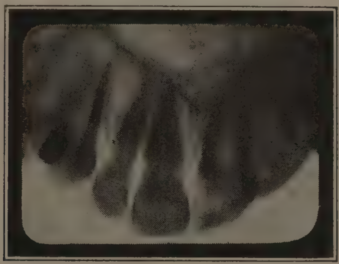


FIG. 516.

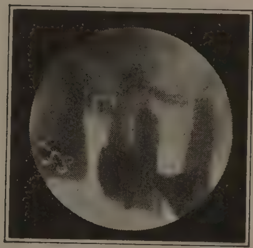


FIG. 517.

It will be interesting to watch this tooth for the next few years, skiagraphing it from time to time, which I hope to do.

In Fig. 517 is shown a picture of an upper molar in which the three roots are very clearly brought out. The picture was taken with the tube at a high angle.

In Fig. 518 is a repeat of the same tooth with the tube low down

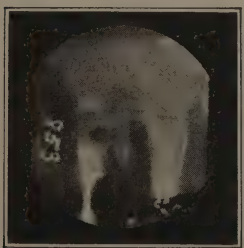


FIG. 518.

FIG. 519.

(LeMaster method) and a Buck molar film being used, the wood block taking the place of the cotton roll.

Strange to say, the first film gives the better picture, which only goes to show that bringing out the buccal roots of an upper molar is largely a matter of luck, the principal feature of which being that the tooth in question has *three roots*, and that they are not bunched.

Fig. 519. The picture shows the second bicuspid is in the jaw, and, therefore, the deciduous tooth should be extracted.

Fig. 520. Here the second bicuspid is shown to be congenitally absent, and, therefore, the deciduous tooth should be preserved.

Fig. 521. A rather unusual case. A lower incisor fractured without known cause.

Fig. 522. It is generally accepted as a fact that the cuspids are never missing, and when not erupted, are somewhere in the jaw. Here are shown the model and skiagraph of the only authentic case I have ever met with in which the upper cuspids were not present.

Fig. 523. A very good example of distortion. The same cuspid as taken from two different angles.

Fig. 524. Another good example of distortion. The same bicuspid taken from three different angles.

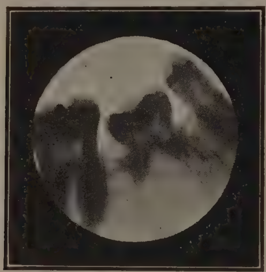


FIG. 520.

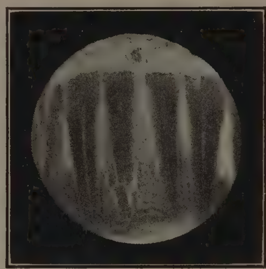


FIG. 521.

Fig. 525. The eruption of an upper central was unduly delayed. A skiagraph revealed a supernumerary tooth—evidently the cause. This tooth was removed, whereupon the central promptly erupted.

Fig. 526. A year after some root canal artist had "protruded" his filling through the root ends of this tooth, I extracted it.

A year later the region was rayed, and these funny little doings appeared upon the film.

Fig. 527. The beginning of trouble at the root end of the bicuspid is plainly shown.

Fig. 528. Here is a typical unerupted mandibular third molar with a radiolucent area, distal and mesial to it, that is nearly always interpreted as infection. Upon the removal of the tooth, it was found surrounded by a fibrous band which proved to be nothing but connective tissue.

Fig. 529. This patient had suffered from very severe arthritis for some two years or more, and was still suffering when her physician said, upon looking at the radiolucent area around the upper cuspid, "I know that it is infected and the cause of her trouble."

The tooth was removed and, one year later, the patient had not improved a bit. That radiolucency is normal to all unerupted cuspids.

Fig. 530. A young lady had been running a slight temperature for several months. The bicuspid was condemned to extraction, and she

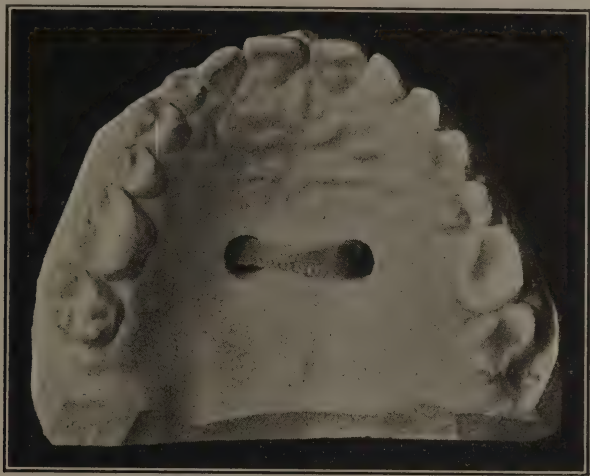


FIG. 522.

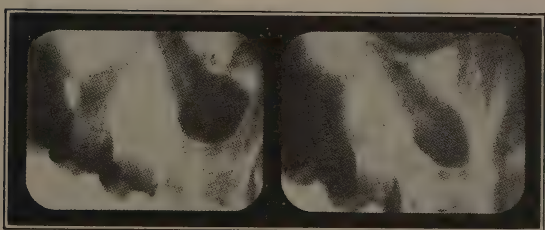


FIG. 523.

came to me for its removal. I refused to extract it. The root canal was filled. In a few weeks her temperature returned to normal, and a year later she was perfectly well.

Fig. 531. An unsuspected cuspid, deeply embedded in the roof of the mouth of an edentulous patient over sixty years of age.

Fig. 532. Judging from the model (or the mouth) it would not be

Fig. 524.

possible to decide as to whether the mal-formed tooth belonged to the deciduous or permanent set.

The skiagraph, however, settles that point conclusively. The fact that the tooth has a single root, proves it to be a permanent bicuspid.

Fig. 525.

Fig. 526.

Fig. 533. Placing a gutta-percha point in a sinus before X-raying the case, will often give the operator a line upon its direction and depth that he could not obtain in any other way. In Fig. 533 is shown such a case.

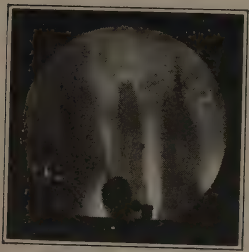


FIG. 527.

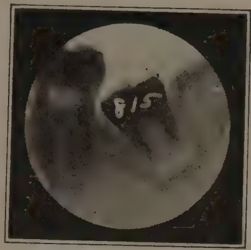


FIG. 528.

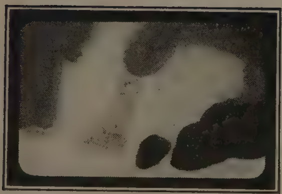


FIG. 529.

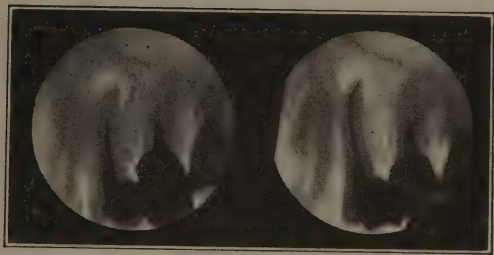


FIG. 530.—This film was taken immediately after the root canal was refilled.

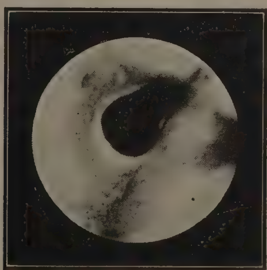


FIG. 531.

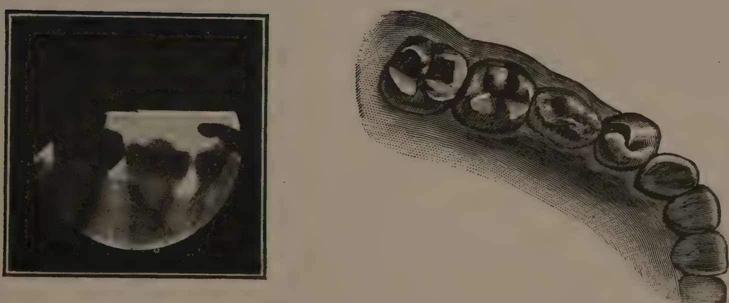


FIG. 532.—The dark streak diagonally across the root is an artefact. This is a glass plate over twenty years old.

The soft tissues do not show upon the film, so that the picture does not present the real difficulties met with in the case.

Fig. 534. At the apex of the central a distinct rarefied area is to be seen, which would be diagnosed as pathology by an inexperienced operator.

Fig. 535. Here is shown another picture of the same tooth, taken at the same time, but from a different angle; and here we see the apical area

Fig. 533.

appears to be normal. This only shows how misleading a skiagraph can be, because, in this case, that tooth is just as perfect as the day it was erupted.

Fig. 536. I do not suppose there is a Roentgenologist (M. D.) in the country who would not mark this central as "infected;" and probably hundreds of radiodontists and other X-ray operators (!) would do the same.

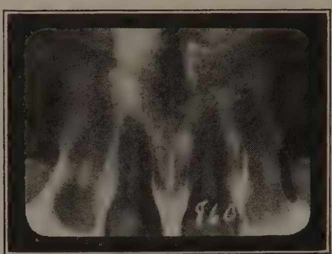


Fig. 534.

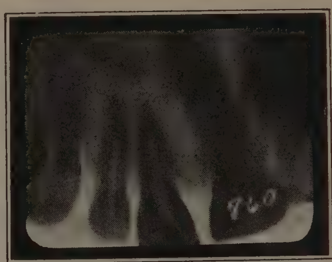


Fig. 535.

Fig. 537. Here is shown another picture of the same tooth taken immediately after the first one. It is not possible to stress this point too much. When the pictures are taken at certain angles, normal radiolucent areas will sometimes appear, in the skiagraph, at the root ends of perfectly normal teeth, and the proper diagnosing of such cases spells the difference between a good X-ray diagnostician and an incompetent one.

Pyorrhea always begins at the gum line. To take a skiagraph, and charge for it, for the diagnosing of pyorrhea, is just robbery, pure and simple. At least that is my idea. I may be wrong.

However, *after*— and not until then—the patient has decided to have the self-evident disease treated, then it is *sometimes*—but not *usually*—*advisable* to take a picture, which may assist in the treatment.

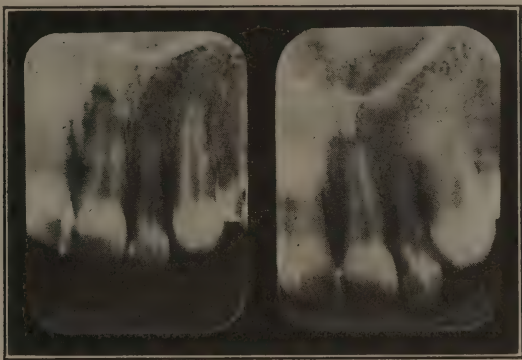


Fig. 536. Fig. 537.

These pictures were printed from a slide loaned by Dr.. Chas. F. Chandler.

In Fig. 538 is shown a very unusual case. A young woman with a splendid set of teeth, the central and lateral being the only ones affected. A platinum point was placed between the teeth before raying them. *Treatment* is not considered of any value in such cases. The gum was laid back, and all (?) of the diseased tissue—bone and granuloma (?)—were

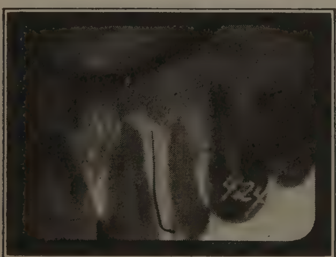


Fig. 538.

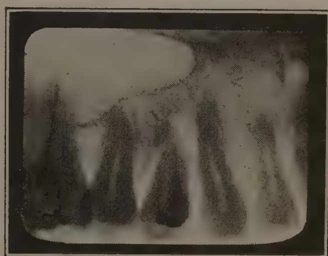


Fig. 539.

removed after which the flap of gum was returned to place and sutured into position and the case looked well one year later.

Fig. 539. Another such case. Tooth restored to usefulness by the same "open view" operation. (First bicuspid.) This tooth was condemned to extraction by a pretty good dentist.

Fig. 540. One, unaccustomed to reading skiagraphs, might say that the root canal filling protrudes through the root end of the bicuspid and

penetrates the antrum, but it undoubtedly does not. The *shadow* of the bicuspid is superimposed upon the shadow of the dense wall of the antrum,—that is all—but the root canal filling protrudes all right.

Daylight Hold-ups.—It is certainly disheartening for those who have the well-being of the public at heart, and who believe that a professional man should be guided by the highest motives, to see the awful dental films,

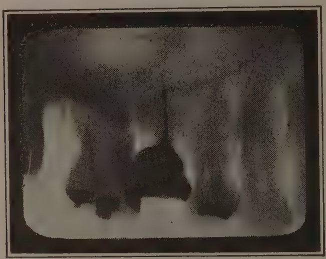


Fig. 540.

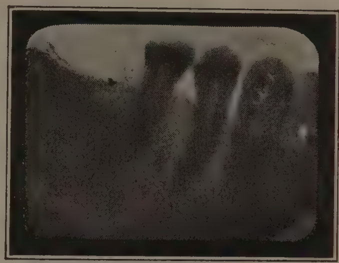


Fig. 541.

and the scandalous diagnoses furnished with them, which a certain class of institutions, specialists, and dentists, as well, turn out.

To charge for a film which is not decipherable, and a faulty diagnosis *based upon it*, is a reflection upon the whole profession.

Fig. 541. The roentgenologist of a high class hospital took this picture, and then told the young lady she had "pus at the end of the root."

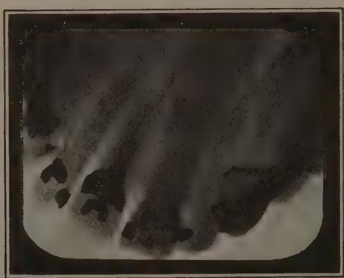


Fig. 542.

To me she came for comfort. A physical examination showed the tooth crown without a flaw—as perfect as the day it was erupted. My own skiagraph showed the root end absolutely normal, as far as one could judge from a skiagraph. The tooth had never hurt her. He was looking for a focus of infection.

Fig. 542. This was "broadcast" by a "dental diagnostician and *radiographer.*" (Shades of Marconi!)

Fig. 543. This is one of a set of ten films—ten films (one film must include the four incisors) being necessary for a diagnosis. The *by-product* of a great medical institution.

FIG. 543.

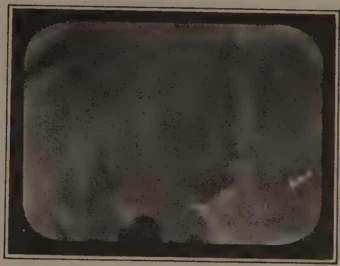


FIG. 544.

Fig. 544. A sample of the regular output of a small hospital in a small town.

Fig. 545. This is a sample of the work of a Roentgen laboratory.

Fig. 546. A diagnosis of an unerupted upper third molar by a radiodontist. He certainly puts the "dont" in "radiodontia" all right.

FIG. 545.

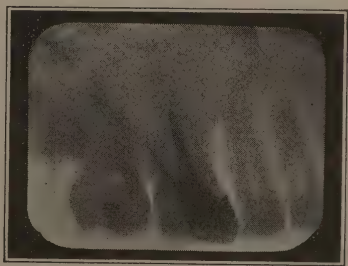


FIG. 546.

STEREOGRAPHS

STEREOSCOPIC SKIAGRAPHS

Thus far, only ordinary skiagraphs—simple shadow pictures—have been shown, and it has been seen that it is not possible to learn from such shadow pictures the relative positions which the several objects, shadowed thereon, bear to one another. If, however, the same laws which apply to the taking of the ordinary well known form of stereoscopic photographs are applied to X-ray work, and skiagraphs are taken accordingly, the resultant "stereographs" are possible of most accurate interpretation.

Most of the doubtful features of the shadow picture are eliminated in the stereograph. In the place of a flat picture without perspective, the stereograph brings into view a translucent model as if made of glass with various tooth roots apparently floating in it, while they, themselves, are also transparent, though, naturally, less so than the alveolar process. The root canals may be clearly followed and, when filled, if any imperfections in the fillings are there, they may be frequently seen. Whether or not a crown post or root filling perforates the side of the root may usually be told. The relative positions of impacted or unerupted teeth are also frequently clearly brought into view.

A stereograph of the root and the wire shown in Fig. 508 would positively reveal the actual position of the wire, whether it was in the canal above or below the root.

Intra-oral Stereographs.—The taking of dental stereographs, upon films held in the mouth, is a comparatively simple process to-day, but many were the trials and tribulations met with in the early days, during which time this present day simple process was being evolved.

All that it is really necessary to know now about this work is that two ordinary skiagraphs of the region involved must be taken upon separate films, from points about two and one half inches (the pupillary distance) apart. The focal distance does not appear to affect the result. I use about eighteen inches.

The patient must not move during the process of changing the films, and the second film should be placed in about the same position as the first and *exactly upon the same plane.* Here lies the difficulty in taking many dental stereographs upon films within the mouth.

The requisites for making and viewing intra-oral stereographs are:

1. A tube stand with stereoscopic shift.

2. Means for readily replacing the first film by a second one, and having them both upon practically the same plane.

3. Suitable "mounts" for the films.

4. Suitable stereoscopes for viewing the pictures.

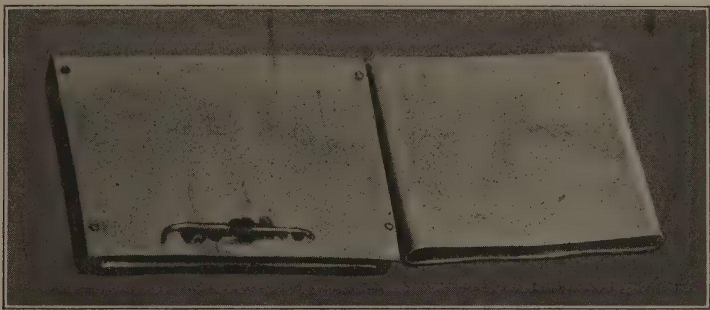
Tube Stand.—Most, if not all, of the modern tube carriers, as sold to-day, are provided with a "stereoscopic shift," so that feature is taken care of.

Stereoscopic Shift.—If the stereoscopic shift is along the arc of a circle, then, once the tube is properly focussed, it needs no other attention than giving it the two shifts—one to the left and one to the right.

If it travels along a straight line, then, at each shift, the tube itself must be tilted so as to focus the rays upon the center of the field to be rayed.

Holding the Film in Position.—While it is possible to take some stereographs by holding the film between the teeth, this method is more or less uncertain, and I do not practice it.

The Tunnel.—In Fig. 547 is shown a tunnel which was devised for the purpose of taking pictures upon horizontal films.



B *A*

FIG. 547.

At A is shown one made of sheet aluminum, while at B is shown another made of an aluminum top, *riveted* to a lead bottom plate. Both of these were hastily and crudely made, but they accomplish the purpose for which they were intended. The "land mark" or guide for registering the films is seen upon their upper surfaces.

With this tunnel in position in the mouth, the films may be slipped in and out without the patient's moving a muscle, and it is more satisfactory to me than when the patient holds the films between the teeth and, therefore, must open and close the mouth when the films are changed.

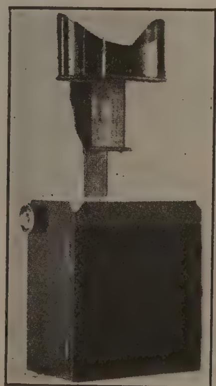


FIG. 548.

The Stereoscope.—After the stereographs are made, they must be viewed in a suitable stereoscope, and as there was no such instrument to be had, one was devised.

In Fig. 548 is shown the original scope, which is still in use to-day, never having been improved upon. It consists of a box containing an electric bulb, and a part of an ordinary parlor stereoscope, all as plainly shown in the illustration.

The top of the box consists of a sheet of opal glass, and under it are grooves, in which one or two other pieces of opal glass may be placed in order to tone the light to suit films of different densities.

The flat bar, supporting the lenses, has an ordinary "rack" attached to one side, which engages with a pinion within the box. The little wheel,

shown upon the left of the box, is attached to this pinion, and so, upon turning this wheel to the right or left, the lenses are moved up or down, and thus the films may be correctly focussed.

Taking the Stereograph.—The patient is seated in the X-ray chair, (Fig. 549) from which the head rest usually used has been removed and replaced by an ordinary photographer's rest. This allows of the head being firmly bound to place by means of surgical bandage. (Fig. 549.)

FIG. 549.—Head bandaged securely to head rest and tunnel in position.

Around the under edge (front and two sides) of the tunnel, some softened modeling compound is attached. The tunnel is then placed in position in the mouth and *held against the upper teeth*, while the lower teeth are closed into the soft compound. In this manner, the tunnel is held against the upper teeth and cannot move.

The tube is focussed upon the center of the field to be rayed, and the stereoscopic shift adjusted to that point. The tube is then shifted one and one-fourth inches to the left. The film with the L upon it is placed in the tunnel and the picture snapped.

The film is removed, replaced by another, the tube is shifted two and one-half inches to the right, and the second picture taken. Both films should be given as nearly the same length of exposure as possible.

Developing the Films.—These films are developed, fixed, etc., as has already been described. If, when finished, they are not of equal density, then the darker one should be reduced to match the lighter one.

Making Prints.—It is possible, of course, to make the usual prints from the films and place these upon mounts to fit an ordinary parlor stereoscope, but so much of the beauties of the original films are lost in the process, that one hardly has the heart to spoil his work in this manner.

FIG. 550.

Mounting the Films.—When dry, each film is placed between two small sheets of glass which are then bound together with gummed strips of paper binding. (Fig. 550.)

Viewing the Stereographs.—In order to study these stereographs, the mounted films are placed upon the opal glass, emulsion surfaces uppermost, the ends with the "land marks" upon them being towards the operator, which was their position when they were exposed.

While the focus of the lenses is being adjusted by means of the little wheel, the films are moved about until the landmarks register and the focus is correct, whereupon the stereoscopic effect is at once produced.

Stereographs cannot be read at a glance. Some little time is required to properly focus a picture, and then considerable study is necessary to bring out all the beautiful details that lie within its mysterious depths.

The Film Holder.—When occasions arise in which it is not possible to get the desired picture upon a horizontal film, then the film holder as shown in Fig. 551 is used, and the method of its making is also shown.

(A) A piece of aluminum plate, No. 30 B. & S., is cut to this pattern.

(B) The slotted edge is then turned over to about a right angle, and the lugs at each end bent over—all as shown.

(C) The slotted edge is then slightly warmed over a Bunsen flame and a piece of softened modeling compound is attached to it. This is placed in the mouth, *plane surface pressed against the inner surface of the jaw*, and held there while the compound is moulded over the crowns of the teeth. The patient then closes down carefully upon it; mouth is

opened, and the plane again adjusted in place in case it had moved away during the occlusion. It is then cooled by means of a jet of cold filtered compressed air or a spray, and then removed. The finished plane in position on a model is here shown. The films enclosed in black rubber, as previously described, have been clamped in place by the little lugs at each end. This is an old illustration. To-day, a Buck film is used instead of the rubber-covered film.

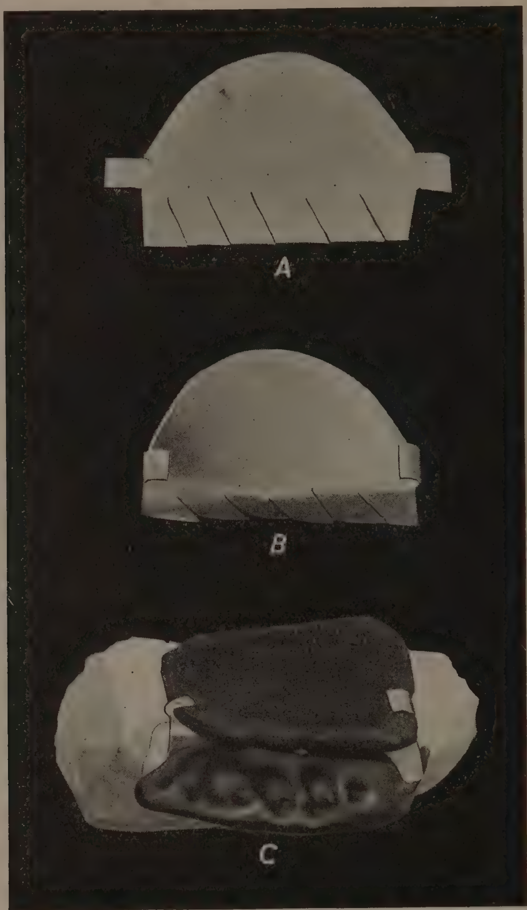


Fig. 551.

The film holder is now placed in position in the mouth, the teeth closed gently against it so as to be assured it goes to place, and the exposure made. The plane is then removed, film taken off, another one put on, the holder returned to the mouth, where it must be replaced in its exact former position, which is readily done, and thus the second film is held in the same plane as was the first. The tube is shifted and the second exposure is made.

With the patient placed in a comparatively comfortable position, so that she can sit immovably during the process, and care being used to carry out these details without the loss of any unnecessary time, perfectly satisfactory stereographs can be thus obtained of teeth of the lower jaw, as well as those of the upper.

Emergency Cases.—When time is pressing, and one wants to read the stereographs immediately, and while the patient is waiting, it is possible to take the films out of the fixing bath, give them a few shakes in the rinsing tank, and place each one between two sheets of *wet glass* and bind them together by means of two rubber bands, place them upon the stereoscope and interpret them at once. (Fig. 552.) When finished viewing them, they can be placed in the washing tank for the full time necessary.

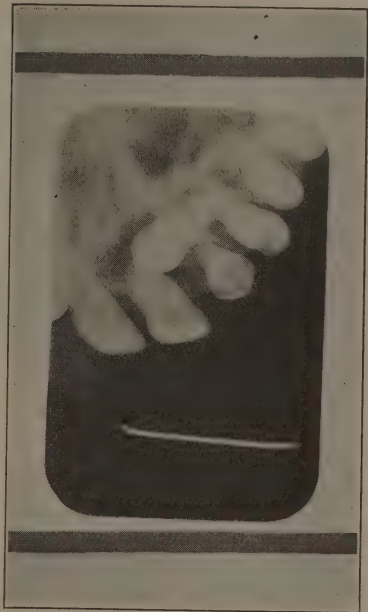


FIG. 552.

Reversing the Films.—There is a most wonderful feature about this work. If the left eye picture is placed on the left, and right eye picture on the right of the stereoscopic box, upon looking at them, it will be found that we are looking through the jaw from the same direction that the rays were thrown. In this case, for instance, with the pictures so placed, we appear to look down through the buccal plate, through the alveolar process and so on. Everything appears just in these relative positions. As a matter of fact, these pictures present a real buccal aspect of the case.

But let us reverse the pictures, placing the right eye picture on the left and the left eye picture on the right, and a most wonderful transformation has taken place, for now we are looking through the jaw from a position within the mouth, and they present an actual lingual aspect. Strangest of all is the fact that viewing pictures from this direction is the more satisfactory of the two, so that the pictures are always reversed for reading.

Another Stereoscope.—One unfamiliar with the working of the stereo scope just described, cannot adjust the lenses and arrange the films to advantage, so when I want to show a set of stereographs to others, a different form of stereoscope is used, and which was devised for this special purpose.

This is shown in Fig. 553. For its use, the films are positioned upon a sheet of clear glass, three and a half by seven, by means of strips of gummed black paper, and then all of the rest of the glass that is clear is also covered with black paper.

There are two grooves at the back of the stereoscope—the one for a piece of opal glass, and the other for the mounted film. When the films are placed in the instrument, any one can easily focus the lenses to suit his eyes, and view the picture to the best advantage, as the bellows cut out all extraneous light and the pictures stand out in bold relief.

FIG. 553.

Landmarks.—In order to view these stereoscopic films, they must be placed in such position that they will "register" with each other. In order to facilitate this registering of the films, a radiopaque landmark or guide is placed upon the tunnel, which naturally casts its shadow upon both films, and these landmarks furnish an infallible guide for this necessary registering.

A piece of copper or brass wire, or ordinary *fuse wire*, which is better still, is stuck on the top of the tunnel with wax, as already shown in Fig. 547.

Distinguishing the Films.—It is also advisable to be able to distinguish the left eye picture from the right, and so a small radiopaque L (a piece of wire bent to shape) is always placed upon the left eye film, and, consequently, it is indelibly marked.

The Value of Stereographs.—While stereographs of other regions in the mouth are occasionally valuable, in my own practice, I have found them to be most frequently needed in cases of unerupted cuspids, and for accurately locating supernumerary teeth.

In orthodontic cases, where a cuspid is unerupted and long past due, it is the accepted practice of the day to cut down upon it and expose it to view.

A plain skiagraph of such teeth is usually very misleading, and a stereograph will give its exact relation to the other teeth, one should always be taken.

Before attempting the removal of some impacted cuspids, stereographs should be taken, as they will undoubtedly indicate whether the teeth should be removed from the labial or lingual surface of the arch, which cannot always be ascertained from a plain skiagraph.

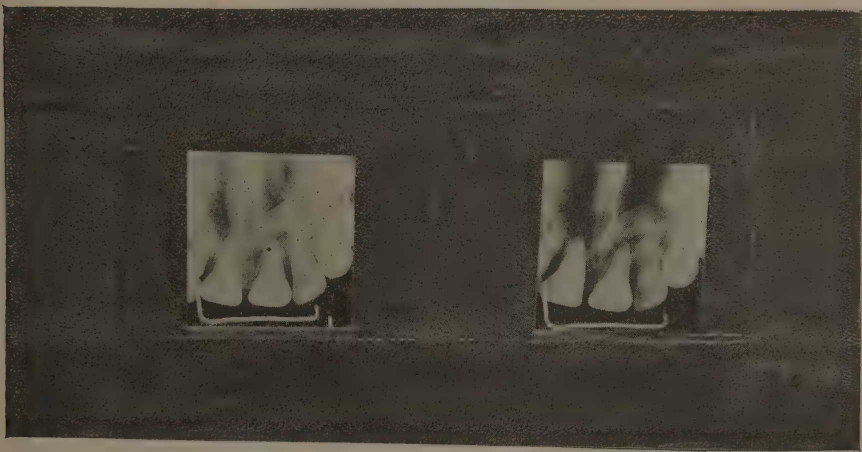


FIG. 554.

In Fig. 554 is shown a very deeply embedded supernumerary tooth. A stereograph located this tooth most accurately, and with it as a guide, its removal was very greatly facilitated.

In Fig. 555 is shown a stereograph of an unerupted, impacted and rather deeply embedded mandibular third molar. I have an idea that the

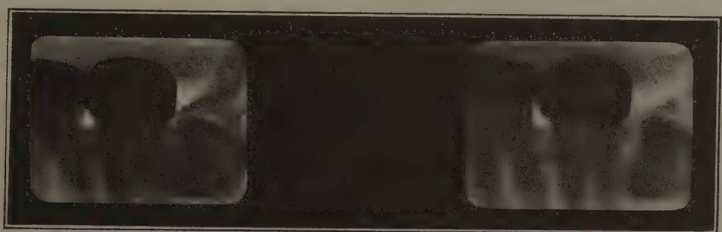


FIG. 555.

taking of a satisfactory stereograph of such a tooth upon intra-oral films is about the "acid test" for this class of work.

Ancient History.—Fig. 556 may prove of interest, because the films used for the first intra-oral pictures that were ever taken were, naturally, kodak films, there being none other available, and the emulsion was not well suited to X-ray work.

The first glass plates used were, naturally, those taken from the ordinary stock of the photo supply houses, and neither was the emulsion upon them suited to the ray. The manufacturers of photographic plates at

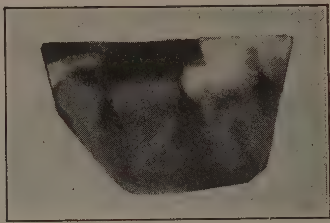


FIG. 556.

once bent their energies to produce a plate especially adapted to X-ray work, and I would get such plates and cut them up into small pieces, and thus I could obtain better pictures than I could get on the kodak film. In

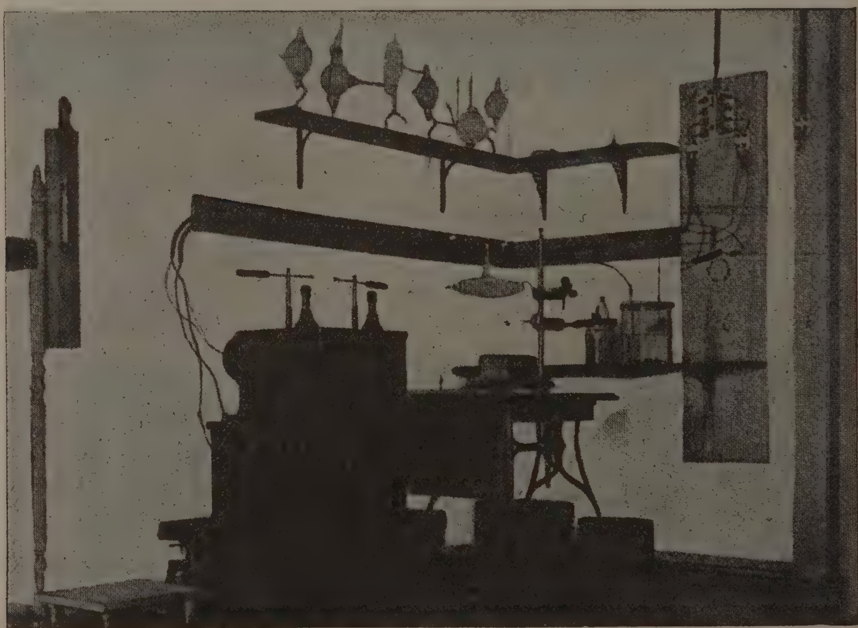


FIG. 557.

this illustration is seen a photograph of such a glass plate. This little plate is a relic of those early days.

Fig. 557 is taken from the *Dental Cosmos.* (Oct., 1899.) It shows the very first dental X-ray laboratory that was ever assembled.

The Tesla coil, the wonderful (!) switch board and tube stand, the crude electrolytic rheostat and the shapes and sizes of the tubes shown, all should prove of interest to the modern X-ray operator with his up-to-date machine.

With the original tube and a kodak film, it was possible to obtain a shadow of an impacted and unerupted mandubular third molar in twelve minutes.

GLOSSARY

Actinic. Producing chemical action.
A. C. Alternating current.
Alopecia. Loss of hair.
Ammeter. Device for registering the amperes flowing through the line.
Anode. The positive terminal within the tube.
Artefacts. Products of errors or reagents.
Cathode. The negative terminal within the tube.
Cathode Stream. Rays being emitted from the cathode.
Cleared. (Photographic term.) Condition of film when hypo has blackened it thoroughly.
Cycles. Frequency of alternations per second in an alternating current.
Crooke's Tube. The original tube used in X-ray work in which the vacuum is one millionth of an atmosphere.
D. C. Direct current.
Electron. The smallest known component of matter.
Electrolyte. (In solution.) A substance capable of being decomposed by an electric current.
Electromotive Force. (E. M. F.) The force that causes electricity to move along a conductor.
Erythema. Redness of the skin.
Fluoroscope. A device for observing shadows cast by Roentgen Rays.
Frilling. (Photographic term.) Emulsion surface becoming wrinkled and undecipherable.
Fogged. (Photographic term.) Denoting that the film has been unduly affected either by light, X-rays or chemicals.
Hypo. Hyposulphite of soda.
Light Struck. (As applied in photography.) When white light has accidentally spoiled a plate or film.
Milliammeter. Device for registering the milliamperes flowing through the line.
Ohm's Law. The strength of an electric current varies directly as the E. M. F., and inversely as the resistance.
Penetrameter. Gage for determining the degree of penetration of X-rays.
Potential. In electrical parlance equals the term *level* in hydrostatics.
Rectifier. A device for converting an A. C. into a D. C. current.
R. Abbreviation of *resistance* in electrical terms.
Shunt. A conductor, connecting two points already in a circuit, through which a part of the current is diverted.
Stereographs. A pair of stereoscopic skiagraphs.
Voltmeter. A device for registering the voltage of the current.

ELECTRICAL UNITS OF MEASUREMENTS

(International Standards)

The Ampere (French). The practical unit of electric current strength and equals the current produced by pressure of one volt through one ohm. Equivalent to the unvarying quantity of current, which, when passed through a standard solution of silver-nitrate in water, deposits silver at the rate of 0.001118 grams per second.

Angstrom Unit (Swedish). A minute unit of length.

The Coulomb (French). The unit of quantity which equals the amount of current transferred by a current of one ampere in one second.

The Farad (Faraday). The unit of electric capacity which equals that capacity which with one Coulomb gives a differential of one volt.

Ion. A molecule of electricity.

The Joule (French). Unit of electric energy which equals the energy expended in one second by the passage of one ampere through one ohm.

Micron. Unit of length.

The Ohm (German). The unit of resistance which equals the resistance of mercury at the temperature of melting ice, 14.4521 grams in mass, and of a constant cross-sectional area, and 106.3 centimeters long (Ohm's law for direct currents only).

The Volt (Volta-Italian). The unit of electro-motive force (pressure) which equals the current which driven through one ohm will produce one ampere.

The Watt (Scottish). The unit of electric power which equals the amount of work done by a direct current of one ampere, at a pressure of one volt. The kilowatt hour is the commercial unit used for the electric current supplied consumers, and equals one thousand watts supplied for one hour. An English H. P. is approximately equal to 746 watts.

Summary.—It may be safely said of dental X-ray work in general that:

1. No dental office is complete without a good X-ray machine at hand.

2. The dental film must be properly developed and cared for.

3. The dentist himself is the one to take his own X-ray pictures, as no one else knows exactly what is wanted, and consequently cannot take them as intelligently as he can.

4. The correct interpretation of films requires experience, which can only be gained by close study and application.

5. The mis-interpretation of films is the easiest thing imaginable.

6. There is a tremendous field for the *unscrupulous dentist* to increase his income by the taking of unnecessary pictures.

7. When any dentist takes unnecessary pictures and charges for them, he is worthy of the contempt of the highwayman, who, at least, takes some chances when robbing his victims.

8. No one writer can be in a position to "cover" this subject from all points of view—the personal element must also be considered—so that the student who really is interested in the subject must read other books upon it; and at this writing, Thomas' "Oral Roentgenology" and Wendell's

"Systematic Development of X-ray Plates and Films" are, I believe, the latest upon their respective subjects.

Both McCoy and Raper have written interesting and instructive books upon this subject, from which much can be learned. The Eastman literature, bearing upon the subject, is most valuable.

Therefore, the student who really wishes to "make good" in dental X-ray work and do his patients full justice, to which they certainly are entitled, should first *subscribe* to the Johnson Text Book and study this chapter well. Then he should *borrow* each of the others and study them. If, however, they cannot be borrowed, then they should be purchased, because they should be read at any cost.

Again one must remember that this art is in its infancy, and the practice is constantly undergoing changes. Certain methods, that are accepted as good practice today, may be discarded for better methods tomorrow; so that possibly some of the details, herein recited, may be out of date before the book is in the press. That, however, is something that cannot be overcome.

The very last thing one should do is to make excuses for his shortcomings. However, it may be permissible to say that an attempt to cover such a wide subject as this in a single chapter only means that many topics must necessarily be treated rather concisely, and some of less importance absolutely omitted.

Nevertheless, it is hoped that the student is here presented with a fair groundwork for his guidance and study of the subject.

Thanks are due to the manufacturers of the various machines and devices shown for the use of their electrotypes and other courtesies as well, and also to the Dental Cosmos and The International Journal of Orthodontia, Oral Surgery and Radiography.

CHAPTER XXXIII

ORTHODONTIA

BY HERBERT A. PULLEN, D.M.D., F.A.C.D.

DEFINITION AND SCOPE—NOMENCLATURE

Orthodontia *is that branch of dental medicine which treats of the etiology, diagnosis, and correction of defective development of the dental arches, dental malocclusion, and consequent facial inharmony.*

Defective development of the dental arches may result in any one of many different deformities, one of the most common and also one of the most severe in its symptoms being illustrated in Fig. 560. The effect

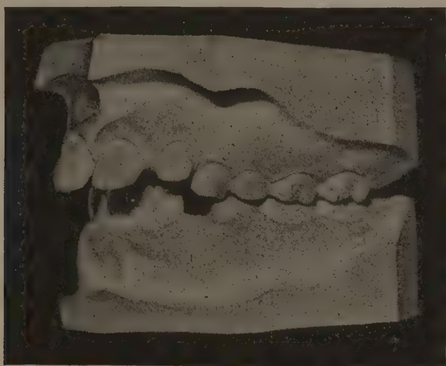


FIG. 560.—Casts of a case of malocclusion.

of such a malrelationship of the teeth and dental arches upon the face is shown in the profile picture of the face of this case exhibited in Fig. 561. It is in the prevention of these conditions, or their correction in early childhood, that orthodontia lends its best efforts, and for the wonderful results in restored occlusion and the production of harmonious and beautiful facial lines, it should be entitled to the recognition of the dental and medical profession as one of the most beneficial and progressive of the specialties of modern medicine.

Nomenclature.—In the terminology of any science, unless special pains are taken in carefully choosing descriptive words of a technical nature according to the exact meaning of the terms used, a confusion of terms is likely to result. Thus, the term, **orthodontia,** derived from two Greek words meaning "straight tooth," and used originally to designate the

science of straightening the teeth, is not specifically and correctly applicable to the science as viewed from a modern standpoint.

The term **"orthopedia,"** from the Greek meaning "straight child," chosen to designate the correction of deformities in children through gentle application of force to the developing bones, is more correctly applicable

FIG. 561.—Photo of patient possessing malocclusion shown in Fig. 560.

to the work of the orthodontist, and is more exactly expressed by the term **"dental orthopedia."**

Orthodontia has thus advanced beyond the teachings which its name implies into the field of **dental orthopedia** to such an extent that there can be scarcely any orthodontic treatment which does not include dental orthopedic considerations and in many cases such esthetic changes in defective facial contour as to warrant the further expansion of the term **dental orthopedia** to **dento-facial orthopedia.**

In this respect, the restoration of esthetic facial contour through orthodontic or orthopedic treatment, might correctly be designated **dento-facial orthopedia,** as suggested by Dr. Case, and may be defined as follows:

Dento-facial orthopedia *is the art of reproducing esthetic facial contour through the correction of defective development of the dental and maxillary arches exhibited in dental malocclusion and defective facial contour.* **Orthodontia,** on account of its specific meaning, as shown by its derivation, can never exactly express the science in its fullest interpretation but, on account of a more generally established usage than **"dental orthopedia"** or **"dento-facial orthopedia,"** it cannot be discarded, and hence is used

somewhat synonymously with these more correct terms throughout these chapters.

Scope of Orthodontia.—Orthodontia, therefore, embraces much more than the correction of malpositions of the teeth, which, in its earlier history, was the limit of its field of operations, and to-day has developed into a highly specialized science, based upon a rational theory and practice.

As a branch of the healing art, orthodontia deals primarily with the development of the teeth and the dental arches, but secondarily, through contiguity of structure and interrelationship of function, it is directly associated with the development of the internal and external face, and indirectly with the functions of respiration, digestion, and nutrition; hence, by this series of related structures and functions, with the health of the whole body.

Following the lines of preventive medicine, orthodontia has also focused its attention upon the growing child, and, for many years the developing of maldeveloped dental arches of children so that full growth and function of the masticatory apparatus has been obtained has been one of its chief aims.

In this respect, the science of *pedology*, which treats of the physical and mental defects of child growth, has much of value along etiological, diagnostic, and therapeutic lines in common with orthodontia.

Diagnostic considerations have assumed such importance as to foster and demand this conception of the scope of orthodontia, which includes as well an intelligent insight into causative factors of abnormal conditions of growth of the dental and maxillary arches, of the adjacent structures of the internal face, the naso-respiratory tract, and also those factors which affect bodily growth and function as a whole.

A more definite etiology, therefore, based upon general as well as local pathology, has been established in orthodontia, for it is clearly recognized that the arrest of growth and disturbance of function of the internal and external face associated with many cases of malocclusion are but symptomatic expressions of disturbances of some vital function of a general rather than a local nature.

Along these lines, the science of *endocrinology*, or the newer physiology, based upon the control of the various functions and of the growth of the body by the organs of internal secretion, the pituitary, the thyroid, et al., concerns the growth of the dental arches as much as it does the growth and development of any other part of the body, so that its full consideration in orthodontia is of great importance.

Among other etiological factors concerned in malocclusion, also, the influence of heredity upon the individual organism as a whole, and its relation to malocclusion and malformation of the jaws is being more gener-

ally discussed in orthodontia, and its importance as a possible etiological factor is taken into more serious consideration.

Furthermore, a rapidly progressing phase of orthodontic treatment which is being more generally and successfully applied by the modern orthodontist is the utilization of the science of *kinesiology*, or therapeutic muscular movements, especially in its relation to prescribed exercises for correcting abnormal muscular habits and developing and strengthening the muscles of the jaws which are weakened from partial disuse in malocclusion. In fact, the every day use of kinesitherapy in the restoration of function of the weakened or abnormal musculature of the jaws and face is considered one of the most beneficial agents in orthodontic therapy.

In addition, the realm of *psychology* has a most interesting bearing upon various phases of the orthodontic field. This is illustrated in the psychological control of timid and fearful children coming under the orthodontist's care, and the awakening in children of various ages of the power of self control as expressed by the development of will power in the conscious control of abnormal muscular habits, and the substitution of normal habits. Children who are afflicted with severe malocclusions and consequent disfiguring and unpleasing facial expressions which frequently produce the effect of subnormal mentality, or even of idiocy in extreme cases, suffer the psychological reactions of sensitiveness and timidity because of these unwarranted mental attributes, and it is a part of the psychotherapy of orthodontia, after the teeth and dental arches have been established in normal and pleasing relations and facial balance and symmetry restored in these cases, to develop in these children a new confidence in themselves, and such self poise as will be expressive of their real personality and enable them to enjoy life and compete with other children without the former physical and mental handicap.

Moreover, it is possible to carry the psychological possibilities of orthodontia still farther, and with the aid of an initial psycho-analysis, to inculcate the proper mental attitude in certain of these children that will enable them to indicate through their facial expressions the charm of an alert, active, and pleasing personality.

It must be obvious from the foregoing description of the scope of orthodontia that this science, like any other branch of medicine, cannot be viewed from the standpoint of its local symptomatology and pathology, but rather in the light of general biologic relations which have to do with bodily growth as a whole, as well as with the growth and functions of the individual cellular tissues.

Again, modern orthodontia is linked up in a very vital and practical way with *art* in its broadest sense, for, many of the harmonious and beautiful lines of the face being dependent upon the normal develop-

mant of the related structures and functions of the mouth and nose, the production of lines of beauty in the face through the development of the dental arches and the correction of malocclusion, by restoring normal balance to the profile, opens up a field of fascinating interest and wonderful possibility. The study of art in its relation to symmetry and beauty of the face thus becomes a necessary adjunct to orthodontia.

Finally, the mechanical appliances by which these restorations of structure and improvement in function of the dental arches, and the corrections of defective facial lines are made possible, call for a comprehensive knowledge of the underlying principles of *physics* and *mechanics*, as well as of their relation to the biological principles involved, so that these operations may be conducted along strictly scientific lines, whereby the proper standards of efficiency in treatment may be maintained with the minimum of conspicuousness and discomfort of appliances and without injury to the dental and oral tissues.

Hence it will be seen that the field of orthodontia is a broad one, requiring a knowledge of the physiological development of the dental arches and associated structures, the relation of associated functions, the local or remote etiological characteristics of malocclusion, its proper classification, diagnosis, and scientific treatment based upon such physiological and mechanical principles as will tend to restore normal relations and functions of the dental arches, full strength and balance of the muscles of the jaws and lines of beauty to the face, and such improvement in the general health as is possible in the restoration of the functions of the masticatory, musculatory, and respiratory mechanisms.

Trend of Modern Theory.—Modern orthodontia owes much of its impulse and present scientific trend to Dr. E. H. Angle,* who, in his presentation of the theory of normal occlusion in its relation to development of the dental arches, and his classification and treatment of dental malocclusion from this basis, gave the first real insight into the broad field of study and investigation of underlying principles in medicine and mechanics which is building up this science as one of the most progressive of modern times.

The later trend of orthodontic investigation has dealt with the earlier developmental conditions which precede the attainment of function of the full complement of teeth in normal occlusion, and a more comprehensive knowledge of the factors which may interfere with these developmental conditions has led to the necessity for, and inauguration of, earlier treatment of incipient malocclusion.

Limitations in Attainment of Normal Occlusion.—It is evident that normal occlusion of the permanent teeth, being the culmination of functional and structural development, may supervene only when the normal

* Malocclusion of the Teeth, 6th Ed., 1900. E. H. Angle.

growth of the dental arches and their associated structures occurs, for if development of the dental arches and related structures is arrested at any stage of growth or is deficient through any cause, abnormal occlusal relations are inevitable.

Malocclusion a Symptom of Maldevelopment.—"Malpositions of the teeth in general, may be considered as the objective symptoms of abnormal growth of the dental arches, usually manifested by an arrest or deficiency in development."*

Thus it is that the problems of malocclusion are referred back to abnormal developmental conditions, the causes of which are often obscure, because of their being involved in the development of the body as a whole, in factors of metabolism, nutrition, and functional insufficiency of various natures.

*The Import of Certain Etiological Factors in Treatment in Orthodontia, Herbert A. Pullen, Dental Cosmos, Dec. 1908.

CHAPTER XXXIV

DEVELOPMENT OF THE DENTAL ARCHES

The recognition of the dependence of normal occlusal relations upon the physiological factors involving as well as preceding the first dentition necessitates a knowledge of the sequence of certain of these developmental processes leading up to the eruption of the permanent teeth and the attainment of normal occlusion.

FIG. 562.—The deciduous dental arches in normal occlusal relations.

The Arches of the Temporary Teeth.—In order to have a logical and chronological succession of recorded observation of facts, it is necessary to study the dental arches at the latest period before the eruption of any of the permanent teeth, Fig. 562, at a time when the deciduous teeth are all *in situ*, and certain physiological processes are about to take place subsequent to the shedding of these teeth and their replacement by the permanent set, these changes, according to the degree of perfection of their physiological performance, having much to do with the normal or abnormal development of the second dentition.

Many cases of malocclusion date their inception back to the time when these processes are taking place, and a proper cognizance of them would

suggest that assistance be given to these natural processes, if necessary to intervene, rather than to hinder or subvert them through ignorance of their normal function, and consequent ill-advised treatment of certain conditions which may present.

Fig. 563 shows a perfect development of the deciduous dental arches in normal relations of occlusion, at the age of four years, at which time all of the deciduous teeth are in position and accomplishing the function of mastication to the degree necessary for the nutrition of a child of this tender age.

The retention of these teeth until the initiative in eruption of the permanent successors has taken place, is a feature of great importance in its bearing upon the normal development of the arches of the permanent teeth, since the premature loss of the deciduous teeth invariably

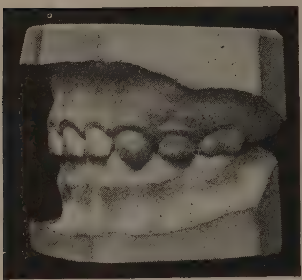


Fig. 563.—The deciduous dental arches at four years.

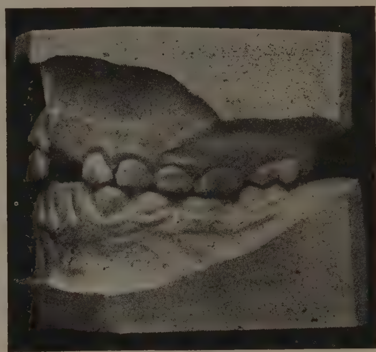


Fig. 564.—The mixed denture at six years. (Same case as Fig. 563).

causes a retardation of development of the maxillary arch which is always productive of a more or less serious malocclusion of the permanent teeth. For example, the premature loss of any one of the deciduous teeth is causative of a lack of development in the region of the lost tooth, in extent according to its mesio-distal diameter and relative importance in the arch.

Directions of Growth of Dental Arches.—As the deciduous dental arches increase in size it will be noted that the growth takes place in three dimensions, length, breadth, and height. Fig. 564 illustrates the growth in height at six years of age over the growth of the same dental arches at four years of age, Fig. 563.

The increase in length and breadth of these same dental arches is best observed from the comparison of the upper dental arches placed side by side, the line in front of the first permanent molars in Fig. 566,

indicating the extent of development of the deciduous arch shown in Fig. 565 before the eruption of the first permanent molars.

In two years of development the alveolar processes have grown downward in the upper arch, and upward in the lower arch, and the first molar teeth have come into occlusion, holding the dental arches the proper distance apart, affording new and broad masticating surfaces for use during the shedding of the deciduous teeth, and by their deep cusp interdigitation, accentuating the perfect mesio-distal registration of the dental arches, which the deciduous teeth initiated.

Developmental Spaces.—While the deciduous arch still retains its full complement of teeth, between the fifth and sixth year, the coordinate and coincident growth of maxilla and mandible is taking place not only in the foward, downward and lateral development, but also in an intersti-

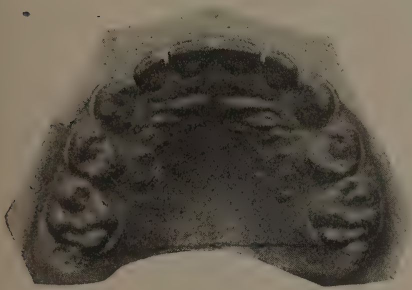


Fig. 565.—Occlusal view of deciduous arch.

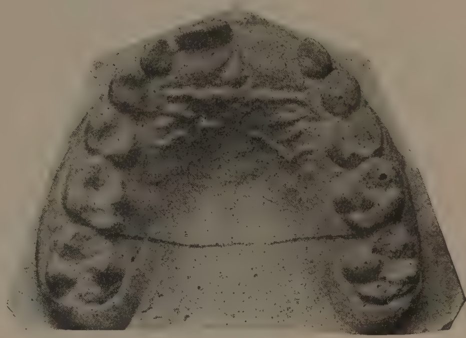


Fig. 566.—Increase in size of mixed denture at six years over deciduous arch in Fig. 565.

tial growth in the alveolar process and maxillæ, due to the erupting teeth, which is evidenced by a separation of the deciduous incisors as lateral development progresses.

Fig. 567 illustrates the arches of deciduous teeth in occlusion just previous to the eruption of the permanent incisors in a child six and one-half years old, a case in which the anterior development of the process has taken place normally, as noted by the spacing between the deciduous incisors. When the dental arches present this appearance just prior to the eruptive period of the incisors, there is every assurance that the eruption of the permanent incisors will occur without crowding.

Occlusal Relations of Deciduous Teeth.—All of the laws of occlusion which pertain to the preservation of the integrity of the permanent arches of teeth are in evidence in a lesser degree in the arches of deciduous teeth, both as to the interdependence of one arch upon the other for the preserva-

tion of form through normal cusp interdigitation, and as to the normal growth dependent upon functional activity of the jaws and related muscles.

It will be observed in the study of the normal deciduous dental arches

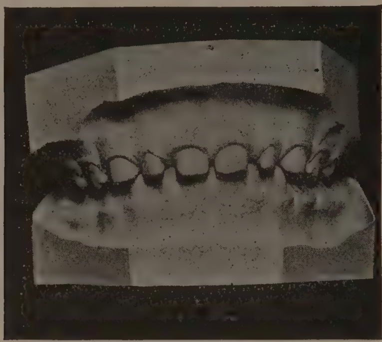


FIG. 567.—Normal spacing of deciduous incisors.

that there is a slight overbite in the incisor region, Fig. 568, and that each upper central incisor overlaps the labial surface of the lower central and one-half of the lateral incisor; each upper lateral incisor overlap-

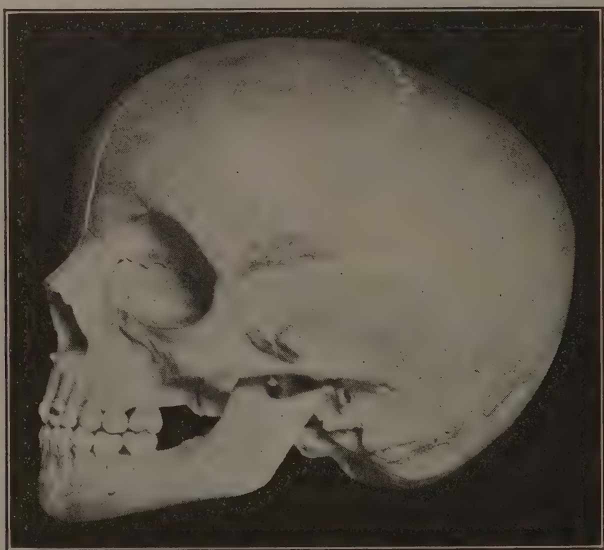


FIG. 568.—Normal occlusion of deciduous teeth.

ping the distal half of the labial surface of the lower lateral incisor, and the mesial incline of the lower cuspid. The antero-posterior interdigitation of the cusps of the cuspids, and first and second deciduous molars is likewise conformative to a normal occlusion and arrangement.

The normal occlusal relations of the arches of the deciduous teeth is a very important factor, through the exercise of normal function, in the normal development of the permanent dental arches, the osseous structures in which they are imbedded, and in the production of normal occlusion of the permanent teeth.

Interdependence of Growth and Function.—The growth of the osseous structures which surround the teeth of both the deciduous and permanent dentures is directly dependent upon their functional efficiency. Quoting from Dr. Noyes* "*Bone is formed and reformed in response to mechanical stimuli, and the entire surface is arranged in harmony with the mechanical stresses which result from the forces applied to the teeth and the surface of the bone.*" "The adult maxillary bones, which are such important factors in the beauty and harmony of the face, are the result of the sum total of all of the forces acting upon them."

FIG. 569.—The transition period of occlusion. (*Noyes.*)

Thus it is that the dental arches, the maxillary bones, and to a certain extent their associated anatomical structures are built up and supported. The function of occlusion in the deciduous teeth, then, plays an important rôle in the development of the internal and external face. The associated functions of respiration and even of deglutition,† and of the muscles of the face have an equally important rôle to play in the harmonious develop-

* Noyes, Dr. Frederick B., The Machine and the Power, *The American Orthodontist*, May, 1908.

† Noyes, Dr. Frederick B., The Alveolar Process. *Journal of the Allied Societies*, June, 1914.

ment of the structures involving the dental arches. The further factors in development of the dental arches and their surrounding osseous structures are those that relate to bodily development as a whole, such as nutrition, metabolism, etc.

Transition Period of Occlusion.—The eruption to occlusion of the first permanent molars, Fig. 569, marks the transition stage from the deciduous to the permanent dentition, initiating a period of dental arch development of much greater extent than that of the deciduous dentition, commensurate with the more complete and pronounced function of occlusion of the permanent teeth, and proportionate to the development of the face as a whole. The first permanent molars, erupting distally to the deciduous molars, Fig. 569, have a function to perform in establishing the normal relationship between the dental arches during the interval of shedding of the temporary teeth, as well as providing the broadest and best masticating surfaces in the mouth during this period. Also, as Dr. Noyes describes them, "the locking of their cusps determines the balance of physiological forces as distributed upon the mandible," referring to "the fulcrum upon which the activity of the muscles attached to the ramus and the posterior part of the mandible, and those attached to the anterior portion of the mandible, are balanced."

Occlusal Relations of Permanent Teeth.—The fulfillment of natural or normal development in the dental and maxillary arches in the completed dentition constitutes a normal and ideal relationship of occlusion of the teeth from which it is possible to note deviations in malocclusion, and a guide for comparison in the restoration of normal conditions, viz., **normal occlusion.**

The characteristics of this normal dental and maxillary development, including the normal development of adjacent structures, are necessarily specified and limited, and may be comprehended in the following definition.

Normal Occlusion *is a condition of perfect relationship existing between the normally formed and arranged teeth of normally developed dental arches when in antagonism, the mandible being in its farthest posterior position, and in exact median register with the maxilla, and both in normal relationship with contiguous tissues.*

Normal occlusion, in the ideal, is seldom found in any type of individual, although the approximation of it in many cases varies but little from the ideal anatomical occlusion. It occurs in all races of man, and from the very earliest time down through the ages to the present day. The fragmentary Aztec skull in Fig. 570 exhibits normal occlusion in one of the earliest races which inhabited the continent of North America.

In all branches of art, such as sculpture, painting, architecture, etc., a model of perfect art is chosen as a guide to reproductions which represent

the highest conceptions of a certain type, whether it be the Apollo in sculpture, the Madonna in painting, or the Renaissance in architecture. Normal occlusion is the highest conception of a type, not a relative nor approximate condition. It is an ideal state of physical integrity, and can

FIG. 570.—Normal occlusion in an Aztec skull. (*Ketcham.*)

only be perfectly conceived in a perfect anatomical subject, which would necessitate, therefore, the normal, typical, and perfect development and relationship of contiguous tissues of the osseous and muscular tissues of the head and face, and the harmonious and proportionate development of the facial lines which are conformative to beauty and harmony of the profile.

It has been suggested that the word "occlusion" alone be used to designate this ideal relationship; that the word "normal" is unnecessary, since if occlusion is anything, it is normal; otherwise, malocclusion is the proper term, but the acceptance of this term without the limiting characteristic which the word "normal" adds to it would be confusing and unwarrantable in referring to the typically ideal anatomical occlusion.

The Normal Defined.—The conception of the "normal" as it relates to the occlusion has received a great deal of attention from those who have been studying orthodontia from a biological standpoint in an attempt to clarify the conception of normal occlusion as it has been generally understood. Dr. A. Leroy Johnson approaches the subject from the standpoint of the "law of variation." He says: "The most obvious thing about the individual organism is its variability. Variation in form and function is universal among living beings." "No part of the living being escapes the influence of the 'law of variation,' hence, an interpretation of the normal as it refers to the dental arch of the individual organism must find a basis in this law and must be determined by the methods employed in the analysis of the material relative to it."

"The word 'normal' means a resultant of correlated factors. As it is used in orthodontia, it refers to either one of two classes of phenomena; either to the general form of a character as seen in a group of individuals, or to a complex of the individual organism. The former signifies a correlation expressing the typical form of an organ or part as seen in many individuals; the latter signifies a correlation which is best suited to the life activities of the individual organism as a whole. Hence, in the study of occlusion, we are concerned with two groups of phenomena, the **'species normal'** and the **'individual normal.'**"

"The **'species normal'** is a concept derived from the observation and comparison of the occlusal relations of the teeth of many organisms." . . . . "If it were possible to make a composite photograph of the occlusal relations of the teeth of a group of individuals from all angles, the result would portray the typical occlusion, the **'species normal.'**"

The Individual Normal.—"The **'individual normal'** is the result of the correlated activity of many parts of the individual organism. It is the result of a complex of physiological processes. The **'individual normal'** refers to the form of occlusion best adapted to the needs of the organism as a whole. It refers to the condition of occlusal relations which is the most effective in maintaining in its most stable form the equilibrium expressed in the life phenomena of the individual organism. It may or may not approximate the **'species normal.'**"

Dr. Johnson defines the **"individual normal"** as "*the most perfect condition of occlusion that the nature of the tissues and the functional activity of the organism as a whole will permit.*"

"Occlusion is, in a degree, an index of the developmental condition of the adjacent structures of the teeth and a register of the forces acting upon them."...."The ideal scheme of occlusal relations commonly called *normal occlusion* is a concept derived from a study of the law of occlusion,

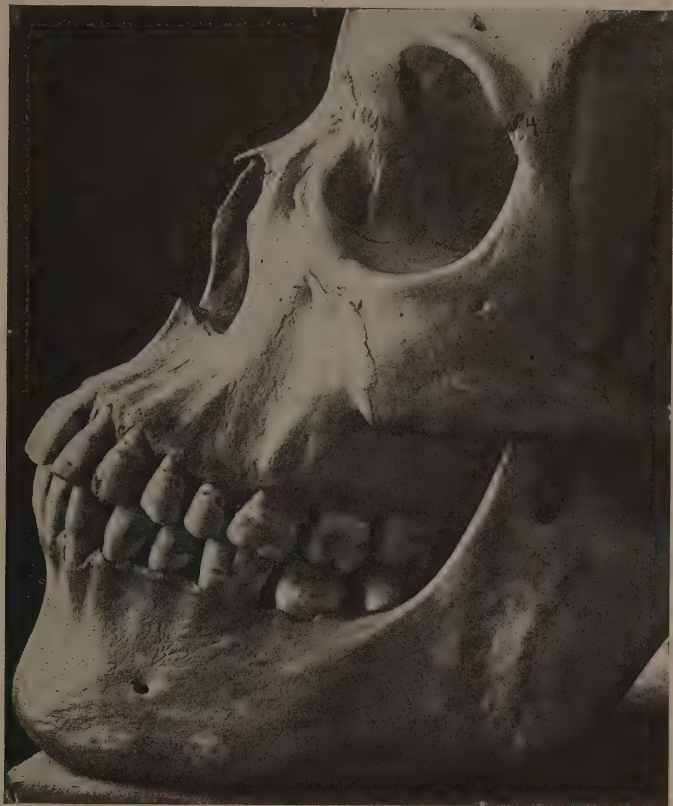


FIG. 571.—Normal occlusion of permanent teeth. (*Broomell.*)

and is the *mental picture*, the *working hypothesis*, essential in an investigation of the nature of occlusion, as it is found in the dental arches of man today."*

Malocclusion, which represents abnormal relations is common to all modern races of occlusion, and may be observed in the mouths of almost all of the people whom we meet, and it is necessary to study the relations of the teeth, the jaws, the muscles of mastication and expression, and related functions in order to understand this variation from the normal relationship of occlusion.

* The Individual Normal, By Dr. A. Leroy Johnson, Proc. Amer. Soc. of Orthodonists, 1919.

The following relations of occlusion of the permanent teeth are based upon the description of normal occlusion by Dr. E. H. Angle.

Characteristics of Normal Occlusion.—Fig. 571 exhibits a skull in which normal occlusion is present, and in which the following characteristics may be noted:

1. The normal shape and size (according to type) of each arch.
2. The normal position of each tooth in each arch.
3. The normal shape and size of each tooth (varying with type) in each arch.
4. The normal proximal contact.
5. The normal occlusal plane.
6. The normal relationship of each arch to the other, and of the occlusal inclined planes of the cusps of the teeth in one arch to those of the other.

The bilateral arrangement of the muscles, the shapes of the arches of teeth, and their harmonious relation to each other; the form, size, and position of the teeth with their cusps interdigitating for mutual support, the proximal contact, the upward curve of the ramus, and the relations of the occlusal planes, all serve the purpose of increasing the efficiency of the organs of mastication, by providing the means whereby a coordination and equilibrium of forces are secured, which are essential for the preservation and function of the organs themselves, as well as for economy of force, and the production of lines of beauty not possible in any other arrangement.

In examining the interdigitation of the teeth upon each lateral half, it will be seen that each tooth has two antagonists in the opposite arch, except the lower central incisor and upper third molar; this arrangement not only providing the greatest support for the teeth individually and collectively, but also allowing the inclined planes of the cusps of bicuspids and molars the best opportunity for articulating during the lateral excursions of the mandible.

Relations of Inclined Cusp Planes.—Beginning at the median line of the dental arches in normal occlusion, the following cusp relations which are conformative to the normal in the bucco-occlusal relations of the teeth may be noted. The upper central incisor is in occlusal contact with the incisal edge of the lower central incisor and one-third to one-half of the lower lateral incisor; the upper lateral incisor is in occlusal contact with the remaining two-thirds or one-half of the incisal edge of the lower lateral incisor, and the mesio-incisal angle of the lower cuspid; the upper cuspid occludes with its mesial incline in contact with the distal incline of the lower cuspid, and its distal incline in contact with the mesial

incline of the buccal cusp of the lower first bicuspid; the buccal cusp of the upper first bicuspid occludes with its mesial incline in contact with the distal incline of the buccal cusp of the lower first bicuspid, and its distal incline in contact with the mesial incline of the buccal cusp of the lower second bicuspid; the buccal cusp of the upper second bicuspid occludes with its mesial incline in contact with the distal incline of the buccal cusp of the lower second bicuspid, and its distal incline in contact with the mesial incline of the mesio-buccal cusp of the lower first molar; the mesial inclines of the mesio- and disto-buccal cusps of the upper first molar occlude with the distal inclines of the mesio- and disto-buccal cusps of the lower first molar; the distal incline of the disto-buccal cusp comes into occlusal contact with the mesial incline of the mesio-buccal cusp of the lower second molar; similar relations of the inclined cusp planes are in evidence in the second and third molars, except that the upper third molar has no antagonizing plane for the distal incline of its disto-buccal cusp. A similar arrangement of the lingual cusps of the upper teeth in their occlusal relations with the lower renders the interdigitation of cusps for mutual support still more pronounced.

Preservative Forces of Normal Occlusion.—Having outlined the positions of the individual teeth in normal occlusion, it is quite important that cognizance be taken of the forces which tend to preserve this normal arrangement which may be enumerated in the order of their influence upon the developing dental arches as follows:

1. Normal growth force.
2. Normal muscular function.
3. Normal respiratory function.
4. Normal arch form, size and interdependence.
5. The proximate contact.
6. Interdigitation of the inclined planes of the cusps.
7. Laws of articulation.

Normal Growth Force.—All forces are functional because of the natural precedence of function before growth of structures. The act of mastication of the teeth is the ultimate object of the building up of the complex structure of normal occlusion of the teeth, and it is in relation to this function that the growth forces of occlusion should be considered.

These forces of growth of the teeth themselves, and their surrounding structures, must of necessity be normal in order that the full normal development of the teeth and dental arches be assured. In this connection one may properly consider as does Dr. Dewey* the normal metabolism of the individual cells of the structures of the teeth and surrounding tissues as being primarily concerned with growth and development of the structures

* Practical Orthodontia, 4th edition by Dr. Martin Dewey.

of the dental arches up to the perfection of development noted in the normal relations of occlusion.

In considering the harmonious growth of the structures of the dental arches, one cannot confine normal growth force to the region of the jaws, for it must be harmonious throughout the entire body in order that the growth of the teeth and dental arches may be normal. The normal growth forces of the entire organism may be upset by abnormal functioning of the pituitary body affecting the growth of the jaws as much as that of any other part of the body.

Normal Muscular Function.—Next to the growth forces of the individual cell and of the entire organism, the forces exerted by the muscular functionating of the jaws is important not only in stimulating the growth of the jaws up to the period when normal occlusal relations of the permanent teeth are in evidence, but also to preserve this relationship through the exertion of sufficient pressure on the teeth and supporting structures in mastication. The mechanical forces are dependent upon these muscular forces which must be balanced as they are through the bilateral arrangement of muscles on both sides of the jaws, and which must be possessed of proper tonicity and strength through exercise in order to fulfill their function. The normal stresses on the bone produced by abnormally acting and unbalanced muscular action is especially noticeable in the jaws.

Nature has wisely provided the balancing of muscular pressure outside of the teeth and dental arches by the lips and cheeks, and inside of the dental arches by the tongue.

Attention has been called to the influence of the muscles of the lips, cheeks, tongue, and other related muscles on the form of the dental arch and the normal or malposition of the teeth by Dr. E. H. Angle.* He has stated "The influence of the lips in modifying the form of the dental arches is an interesting study, and almost every case of malocclusion offers some noticeable and varying manifestation of it." . . . "Normally there is a restraining influence exerted upon the upper incisors and canines by both upper and lower lips. This force is exerted automatically in response to almost every emotion, and results in maintaining the teeth in harmony with the graceful and beautiful curve of the normal individual arch. In cases of malocclusion, strikingly characteristic abnormalities of lip function are often noticeable leading to the suspicion that more often than is recognized the pecularities of lip function may have been the cause of forcing the teeth into the malposition they occupy."

"The result of pressure from the tongue in exerting force upon the inside of the arch is also a factor of great importance in determining the form of the arches and the positions of the individual teeth."

* Malocclusion of the Teeth, 7th edition, by E. H. Angle.

In this respect, Macewen* remarks, "The effect of the soft tissues in maintaining the form of the bone may be considerable, even the weight of the tissues have their result. The tongue, physically at least, is a soft organ, and yet its complete removal often produces in the course of years a marked alteration in the shape of the lower jaw, which generally falls inward so as to permit the teeth to slope markedly toward the buccal cavity. *Normally the form of the lower jaw is maintained by the soft tissues within the mouth.*"

The muscles engaged in the functions of respiration, deglutition, speech, and even expression of the face have also each a correlated part in the functions of the teeth and dental arches and must be considered among the functional forces whch are preservative of the normal in occlusal relations.

Normal respiratory function in particular, through the interrelationship of the muscles concerned with respiration and mastication, as well as through the influence of normal atmospheric pressure and the function of nasal breathing, has a very marked effect in preserving normal arch form and integrity, and these normal structural conditions are easily changed and muscular functions perverted if mouth breathing or other defect in normal nasal respiration should be established.

The functional forces of occlusion as exhibited in the form, size and interdependence of the dental arches, the proximate contact, the interdigitation of the inclined planes of the cusps of the teeth, and the laws of articulation, are all dependent upon the functional forces previously described, viz., upon normal growth force, and normal muscular and respiratory function.

Normal arch form and size are necessary in preserving normal occlusion, the former providing the arrangement of a large number of teeth in a small compass, arranged in two opposing dental arches of equal size and number of teeth, occluding in such a manner that the closure of one over the other in occlusion and articulation is continually preservative of their integrity. They are thus interdependent and the loss of even one tooth from one dental arch is sufficient to destroy not only the integrity of the one arch, but to change the form of the opposing dental arch.

The proximate contact, while apparently an inert factor, nevertheless exerts its influence in the preservation of arch form, in the same manner that the close contact of each separate stone in an arch of masonry exerts its separate influence in the support of that arch. The loss of a single tooth destroys the support of all the rest of the teeth in a dental arch through the loss of the proximate contact of the one missing tooth, and reacts unfavorably upon the integrity of the opposing dental arch.

* The Growth of Bone, by Wm. Macewen, page 22.

The interdigitation of the inclined planes of the cusps of the teeth is one of the strongest forces of occlusion through the bilateral arrangement of similarly formed teeth; the inclined planes of the cusps of the cuspids, bicuspids, and molars of one arch occlude with those of the other in such a manner as to exert a continual force to bring back these teeth to centric occlusion after each lateral excursion of the mandible, the inclined planes of the incisors being so arranged that they do not interfere with the lateral movements of the mandible, and yet exert an influence to preserve the positions of the upper and lower incisors in occlusion.

The laws of articulation governing the movements of the mandible, the relations of the occlusal plane, and the interdigitation of the cusps of the teeth, are the final determining forces which preserve the relations of normal occlusion and should be carefully studied in their various phases.

The object of this complex interdigitation of cusps is to give the greatest support, not only to the teeth individually but as a whole, their sizes, forms, and positions of cusps and inclined planes being best adapted for this purpose.

Distinction between Occlusion and Articulation.—The synonymous use of the terms "occlusion" and "articulation" is not in accordance with their specifically different meanings, as generally understood by those who have carefully studied them.

Articulation *is the relation between the antagonizing surfaces of the teeth of maxilla and mandible during the lateral and protrusive excursions of the latter, dependent upon its universal articulation at the glenoid fossa.*

There are three distinct stages of articulation, viz., *incision*, *attrition*, and *occlusion*. The first two stages represent the mandible in motion; the last, the mandible at rest, the teeth being closed.

The commonly accepted use of "occlusion" is in reference to the relation of the interdigitating cusps of the teeth, whether there is a normal- or a mal-occlusion present, and it may be definitely described as follows:

Occlusion *is the most constant static relationship of the antagonizing surfaces of the arches of teeth in interdigitation.*

Occlusion is the passive phase of articulation, as compared to the active phases of incision and attrition. Occlusion represents the static, and articulation the dynamic, relation between the arches of teeth.

Some writers have argued that occlusion should represent all that is meant by articulation in its relation to orthodontia, but such a generalization of the term would be absurd, and any attempts at diagnosis of malocclusion from such a variable base would only result in confusion. However, it is impossible to completely separate these terms in their bearing upon the normal relationship of the arches of teeth, so intimately are they connected. A normal occlusion necessitates a

normal articulation, and a normal articulation necessitates a normal occlusion.

The laws of articulation produced the perfectly formed arches of teeth, the depth of the overbite, the length of cusps, and relations of occlusal inclined planes, so that the definite form and positions of the teeth and relations of the arches known as normal occlusion was a possibility. In occlusion, the lines of force are constant in their direction; in articulation, they are ever changing, varying as the relationship between the arches of teeth causes stress to be made between antagonizing tooth surfaces in constantly changing angles.

The Curve of Spee.—The so-called "compensating curve," or "curve of Spee," bears such an important relation to the length of cusps and overbite that a brief description of it will aid in its understanding. The "curve

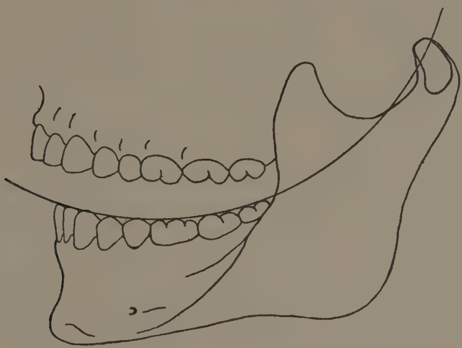


FIG. 572.—Diagram of curve of Spee.

of Spee" is the segment of a circle, the path of the arc of which touches the edges of the lower incisors, the point of the lower cuspid and the tips of the buccal cusps of the lower bicuspids and molars, and passes either anteriorly or posteriorly to the articular face of the condyloid process (Fig. 572).

In the relation existing between the length of molar and bicuspid cusps, the overbite, and the "compensating curve," or "curve of Spee," the radius of the circle on which this curve is superinscribed is longer or shorter in direct proportion to the length of the cusps and the depth of the overbite *i.e.*, a long or deep overbite indicates a "curve of Spee" inscribed on the circumference of a circle with a short radius, and *vice versa*. Also, this radius is shortest in those cases in which the angle of inclination of the glenoid fossa is the greatest, and longer in proportion to the approach of the angle of inclination of the glenoid fossa, and hence the path of the condyles to the horizontal.

The abnormal variation of the "curve of Spee" in certain types of malocclusion is sufficient evidence of the importance of giving it due

consideration in the diagnosis and treatment of malocclusion, cases of which will be later described.

Relations of External and Internal Anatomy.—A very interesting illustration of the relation of external and internal facial development may be observed in a sagittal section of a typical skull, Fig. 573, made by Dr. Cryer. The profile appears proportionate in the development of its

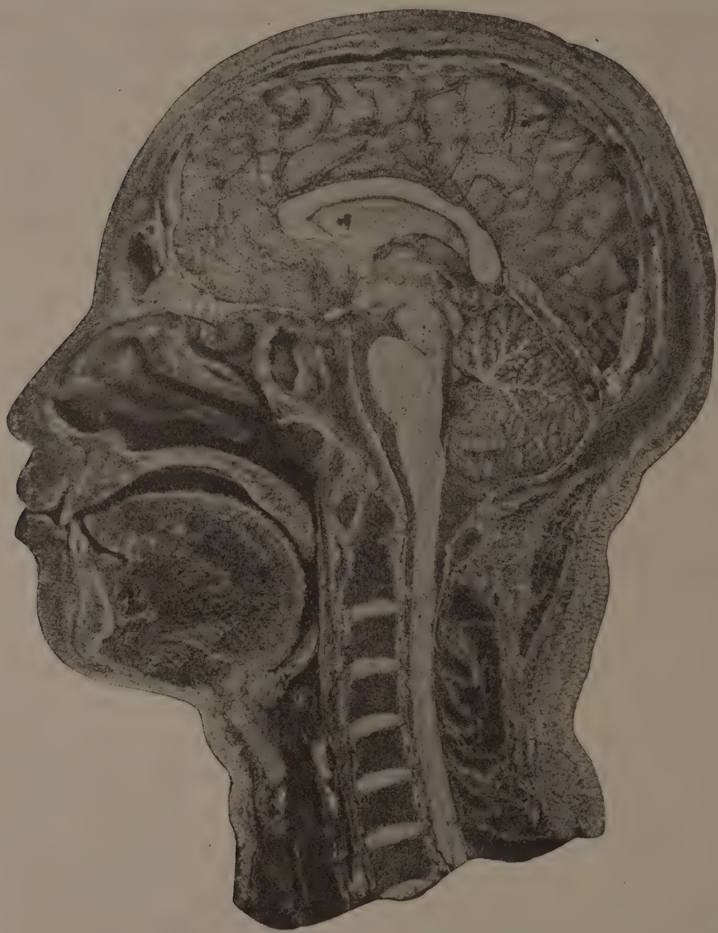


FIG. 573.—Sagittal section of frozen head showing well developed internal face. (*Cryer.*)

various divisions, and a view of the internal anatomy reveals well-developed osseous structures and sinuses in the middle third of the face, and a typically normal development of the maxilla and mandible, and a tongue which almost completely fills the oral cavity.

Dr. Cryer has demonstrated by many sections of the frozen heads of cadavers that variation of the internal anatomy of the face and head is of such frequent occurrence that typical and symmetrical development of

the corresponding osseous structures and sinuses of the two lateral halves of the head is the exception rather than the rule, thus accounting in part for such distinctly noticeable variation in development of the superficial muscular and other tissues.

Normal Development of Associated Anatomical Structures of the Internal Face.—In order that a clearer idea of the field of the orthodontist may be engendered, a study of the internal facial anatomy from a vertical transverse bilateral section of the head, as shown in one of Dr. Cryer's

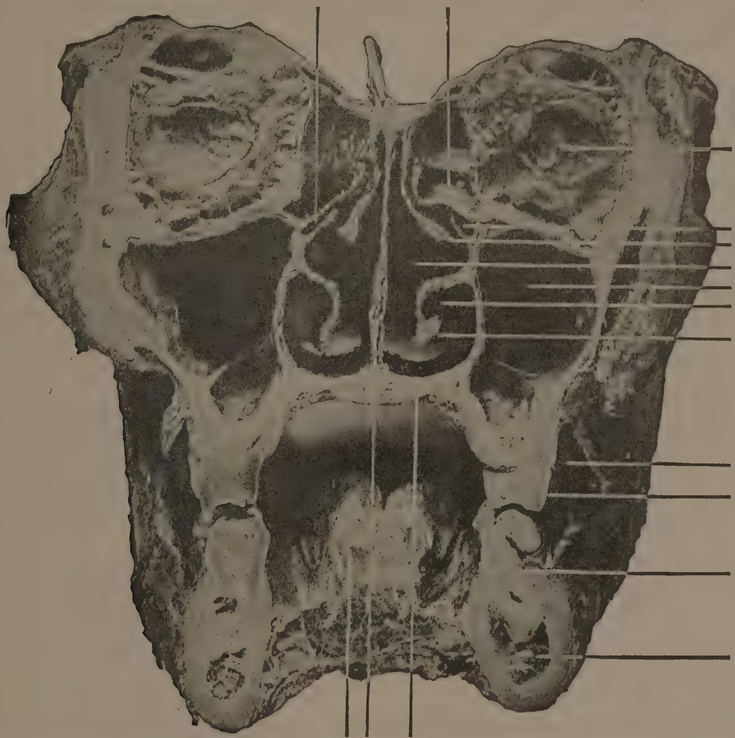


FIG. 574.—Vertical transverse section of frozen head exhibiting full development of maxillary arches, and maxillary and nasal sinuses. (*Cryer.*)

dissections, Fig. 574, revealing comparatively normal development of the maxillary arches and associated structures and sinuses, may serve to illustrate how closely the internal structures are associated, and to what extent they are interdependent for normal growth and function.

Immediately above the floor of the hard palate may be observed a straight nasal septum, dividing the internal nose into two large and well formed meati, adjacent to which the fully developed maxillary sinuses are situated.

This normal and proportionate development of associated anatomical structures of the internal face is not a chance coincidence, but the result of

a functional and structural relationship which is most important to the diagnostician.

First in importance in the development of these associated structures of the mouth and nose is the function of mastication, the natural action and reaction of the teeth of the mandible against those of the maxilla assisting in the development of the dental and maxillary arches, and thereby, in the development of the floor of the nose and associated sinuses etc.

Second in importance in the development of the dental and maxillary arches is the function of normal nasal breathing, which is only possible with properly developed nasal meati.

Abnormal breathing disturbs normal developmental functions, and with deficient respiratory powers, as in the mouth-breather, the teeth seldom come into contact sufficiently to obtain the requisite amount of occlusion and articulation necessary for proper development of the arches.

A third factor in the development of the dental arches and associated structures is the normal action and full strength of the muscles of the face and jaws, the masseter, temporal, external and internal pterygoids, the platysma myoides, et al., the influence of which is correlated with that of occlusion and respiration.

Coordination of Functions.—It will be apparent, therefore, that coordination of the normal functions of respiration and occlusion and associated muscular action is necessary for the symmetrical and proportionate development of the internal face, the nasal cavities and associated sinuses, and the maxillary and dental arches.

Such symmetrical development of related parts implies as well the existence of full nutrition, and the absence of any untoward etiological factors which would tend to diminish functional influence or lower the vitality in any way.

Any local functional and developmental disturbance may be the result of general systemic conditions, of lowered vitality from whatever cause, so that any local pathological manifestation in diminished or perverted function and consequent modified anatomical structures should be considered in relation to the health of the whole organism.

The association of nasal stenosis, mouth-breathing, weakened or abnormal muscle action, arrested development of the maxillæ, and dental malocclusion, is sufficient evidence of the interdependence of function and structure in these associated regions to convince the most skeptical of the importance of the study of the pathological anatomy of the internal face with a view to the discovery of certain causative factors, which through treatment will assist in the remedy or cure of abnormal developmental conditions requiring an intelligent differential diagnosis.

It is primarily, then, upon the structural continuity of the maxillary arches with the structures of the nose, and upon the contiguity of the internal sinuses, as well as upon the correlation of the functions of occlusion and respiration, and muscular action that the possibility of influencing development and restoring function in these correlated parts of the face is based. These several relationships will be further considered in the chapter on etiology.

CHAPTER XXXV

MALOCCLUSION AND ITS CLASSIFICATION

Definition of Malocclusion.—While the knowledge of the normal developmental processes leading up to and culminating in normal occlusion as described in the foregoing pages is essential to the student of orthodontia in order that he may understand the manner of the growth of the dental arches and associated structures when the forces of occlusion are working in coördination, it is with the variation from the normal relations of occlusion known as *malocclusion* that the orthodontist has to deal. Malocclusion has been variously defined but the following definition is simple and comprehensive.

A malocclusion is any variation from a normal occlusion either in size, shape, or relation of dental arches, or perversion of inclined planes of the cusps of the teeth.

Malocclusion is usually a retarded stage of development of the dental arches often due to the lack of nutrition or function during their growth; it may be a malrelationship of the dental arches due to an interference with normal respiratory or muscular forces; again, it may be an accidental misplacement of a single tooth due to maleruption and perversion of the forces of the inclined planes of the cusps.

Perversion of Normal Forces of Occlusion.—In any case malocclusion is a perversion of the forces of normal occlusion, either functional or mechanical. At some period of the growth processes of the dental arches, either in embryo, in infancy, or during the earlier years of childhood, the balance of the forces which produce the normal in growth of the dental arches is interfered with, and arrest of development of the dental arches and malocclusion is the result.

Again, as one dental arch is dependent upon the other for the preservation of its form, size, and the position of its teeth through the forces of occlusion and the influence of the inclined planes in normal occlusion, a malocclusion in one dental arch implies a similar condition in the opposing arch through the action of the same forces. Thus, if the lower dental arch is narrow, and the teeth crowded, the same conditions will be found in the upper arch as a result of the perversion of the forces of occlusion.

Even with normally developed dental arches, if a permanent upper incisor tooth is deflected lingually in eruption by the too long retained root of its predecessor, it will engage the lingual inclines of the lower incisors

and be permanently locked in malocclusion through the influence of the inclined planes.

Malpositions of the teeth in malocclusion are but objective symptoms of abnormal or arrested development of the dental arches.

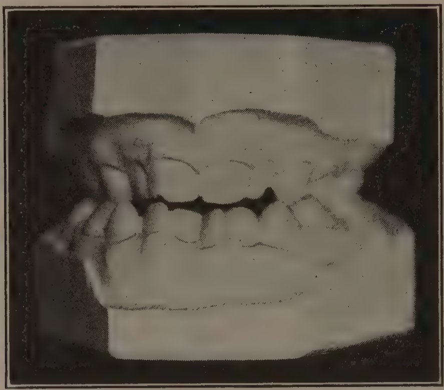


FIG. 575.—Deciduous dental arches exhibiting lack of incisor spacing and arrest of development.

This arrest of development is distinctly seen in the arches of the temporary teeth, Fig. 575 and in the simpler cases exhibits a lack of full spacing for the eruption of the permanent incisors, or even a crowded condition of the temporary incisors themselves. Such arrest of development of the deciduous dental arches is not readily overcome by nature and usually exhibits a similar retardation or deficiency in growth of the permanent dental arches.

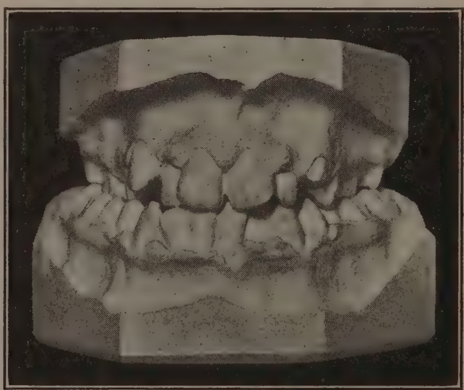


FIG. 576.—Malocclusion of the permanent teeth exhibiting arrest of development of the dental arches.

Arrest of development is shown in the arches of the permanent teeth in the simpler cases by a narrowness or a contraction of both dental arches,

Fig. 576, and the malignment of individual teeth in both arches. In the more complex cases, arrest of development or abnormal development is exhibited by malrelationship of the dental arches complicated by narrowness, malpositions of the teeth, and perversion of the occlusal plane. Occasionally, overdevelopment of the dental arches, another perversion of the forces of occlusion, is found in a malocclusion.

An analysis of the various forms of malocclusion which occur has resulted in their division into a few primary forms.

Fundamental Pathological Conditions in Malocclusion.—It has been pointed out by Dr. Lischer that four fundamental pathological conditions conjoin in malocclusion, viz., *Malposition of the Teeth*, *Malrelation of the dental arches*, *Malformation of the jaws*, and *Malposition of the Mandible.*

Designation of Malpositions of Individual Teeth.—The nomenclature of Dr. Angle in designating the malpositions of individual teeth is based upon their deviation from the "*line of occlusion*" which he defined "*as being the line with which in form and position according to type, the teeth must be in harmony in normal occlusion.*"

According to this nomenclature, if a tooth is outside of this line it is in *labial*, or *buccal occlusion;* if inside of this line it is in *lingual occlusion;* if it is *forward of this line* it is in *mesial occlusion;* if in the *reverse direction*, it is in *distal occlusion;* if rotated upon itself, in *torso-occlusion;* teeth which have been elongated beyond normal relations are in *supra-occlusion;* and those which are insufficiently elevated are in *infra-occlusion*. Dr. Lischer has suggested the use of the ending "*version*" combined with *labio*, *linguo*, *mesio-disto*, *torsi*, *supra*, and *infra*, as being better terminology and somewhat simpler. Thus *labioversion* would indicate the same malocclusion as *labial occlusion*, *etc.* Various combinations of these prefixes may be used to designate two or more malpositions of a tooth. For example, a central incisor may be in *mesioversion*, *labioversion* and *torsiversion*, would be designated as *mesio-labio-torsiversion*. A transposed tooth would be termed *transversion;* an impacted tooth would be designated as *perversion*.

Malrelation of the Dental Arches.—Under this heading is included the mesio-distal variations of the dental arches, and is embodied in Dr. Angle's classification of malocclusion which represents three distinct classes.

Class I. Angle's Classification of Malocclusion.—To the **first class** belong those cases of malocclusion which are characterized by normal mesio-distal relations of the dental arches, with contracted and undeveloped maxillary arches, especially in the anterior portion, in which the teeth often assume varied forms of individual malocclusion, and often simulating in this anterior region, the peculiarities of Classes II and III, both in the occlusion and facial deformity.

Class II.—In the **second class** of malocclusion are placed all those cases in which the lower dental arch is distal to the upper on one or both lateral halves, having two divisions of bilateral distal occlusion, the **first division** being characterized by protruding upper incisors, usually mouth-breathers, and having a **subdivision** in which the distal occlusion is confined to one lateral half, the other half being in normal mesio-distal relations; the **second division** having retruded upper incisors, usually normal breathers, and its **subdivision** having the distal occlusion on one lateral half of the dental arches only.

The facial profile of a case of the **first division of Class II** is usually diagnostic of the occlusal relations, the upper lip being short, and revealing the protruded upper incisors, and the receding chin indicating the distal occlusion. As these cases are usually mouth-breathers, the characteristic open drooping mouth and peculiar tension of the facial muscles is a sure indication of naso-pharyngeal obstruction of present or previous date.

The facial deformity is not so pronounced in the **second division,** the patients usually being normal breathers, the upper lip being of proper length, but the features disfigured by the receding chin and lower third of the face.

Class III is characterized by a position of the lower arch which is mesial to the upper, with protruding lower incisors, having a **division** in which the mesial occlusion is bilateral and a **subdivision** in which the mesio-distal relation to the upper is normal in one lateral half of the lower arch and mesial to normal in the other.

The facial profile is correspondingly deformed, the chin being prominent, the middle third of the face undeveloped, the angle of the rami of the mandible being more obtuse than normal, and, in some cases of long duration, there is scarcely any discernible angle between the point of the chin and the articular ends of the condyles. This latter type of Class III cases would be included under the designation, *Malformation of the Mandible.*

Mouth-breathing is frequently observed in Class III, and its existence in any case serves to increase the inharmonious lines of the already deformed face.

A very rarely found combination of Class II and Class III, although not observed in sufficient numbers to be worthy of more than casual record, is one in which the occlusal relations of the dental arches present the peculiar condition of being in distal occlusion upon one lateral half, and in mesial occlusion upon the other half of the mouth.

As diagnostic of these various classes, the variation from the normal mesio-distal relations is usually best indicated by the relative mesio-distal relations of the upper and lower first permanent molars in occlusion, since they present a history of the longest lived occlusion during the ages

in which malocclusion usually presents, and having such an important part in the building of the permanent dentition as to be appropriately styled "the bulwarks of the dental arches." In the relation of the mesio-buccal cusp of the upper first molar to the buccal groove of the lower first molar Dr. Angle has designated this relationship as the "key to occlusion," and it is to the first molars that attention is first directed in classifying any case of malocclusion to note the normal mesio-distal relation of the dental arches, or *neutroclusion*, the distal relation of the lower arch, or *distoclusion*, and the mesial relation of the lower arch or *mesioclusion*, these terms being suggested by Dr. Lischer.

Classification Chart.—In order that the principles upon which this classification is based may be the more readily understood, the author has arranged the three classes and their divisions in comprehensive chart form in Figs. 577 and 578, the right and left lateral halves in occlusion being represented in each section, with the line of diagnosis intersecting the occlusion of the mesio-buccal cusps of the first permanent molars of each class, and illustrating at a glance, the deviation from the normal mesio-distal relations of each lateral half in each class, division and subdivision.

The use of the upper first molar for the purpose of noting mesio-distal variation of the lower dental arch presupposes a certain unvarying stability or a fixed position of this tooth in relation to the maxilla and the adjacent anatomical regions, which might be understood as being absolute, but such is not the case.

Cases have been reported in which the upper first molar was mesial or distal to its normal position in the arch, although the infrequence of these cases and their observance only affects the classification as far as certain details of the treatment is concerned, the main points of the treatment indicated thereby being essentially unaffected.

In simple, the indications for treatment as observed in the chart are first, the restoration of normal shape and size of the dental arches in each class, second, the restoration of the normal mesio-distal relations of the arches in Classes II, and III.

Infraversion.—Infraversion, or lack of occlusion of the teeth, is a condition of abnormal development occurring in several different forms, and more or less common to all classes of malocclusion requiring special description in a classification based upon the mesio-distal variations only of malocclusion.

Varying as it does from the slight infra-version of one or two teeth to complex cases in which the entire dental apparatus is involved, its diagnosis, in any extensive form, places the presenting case in the class of the most difficult to treat.

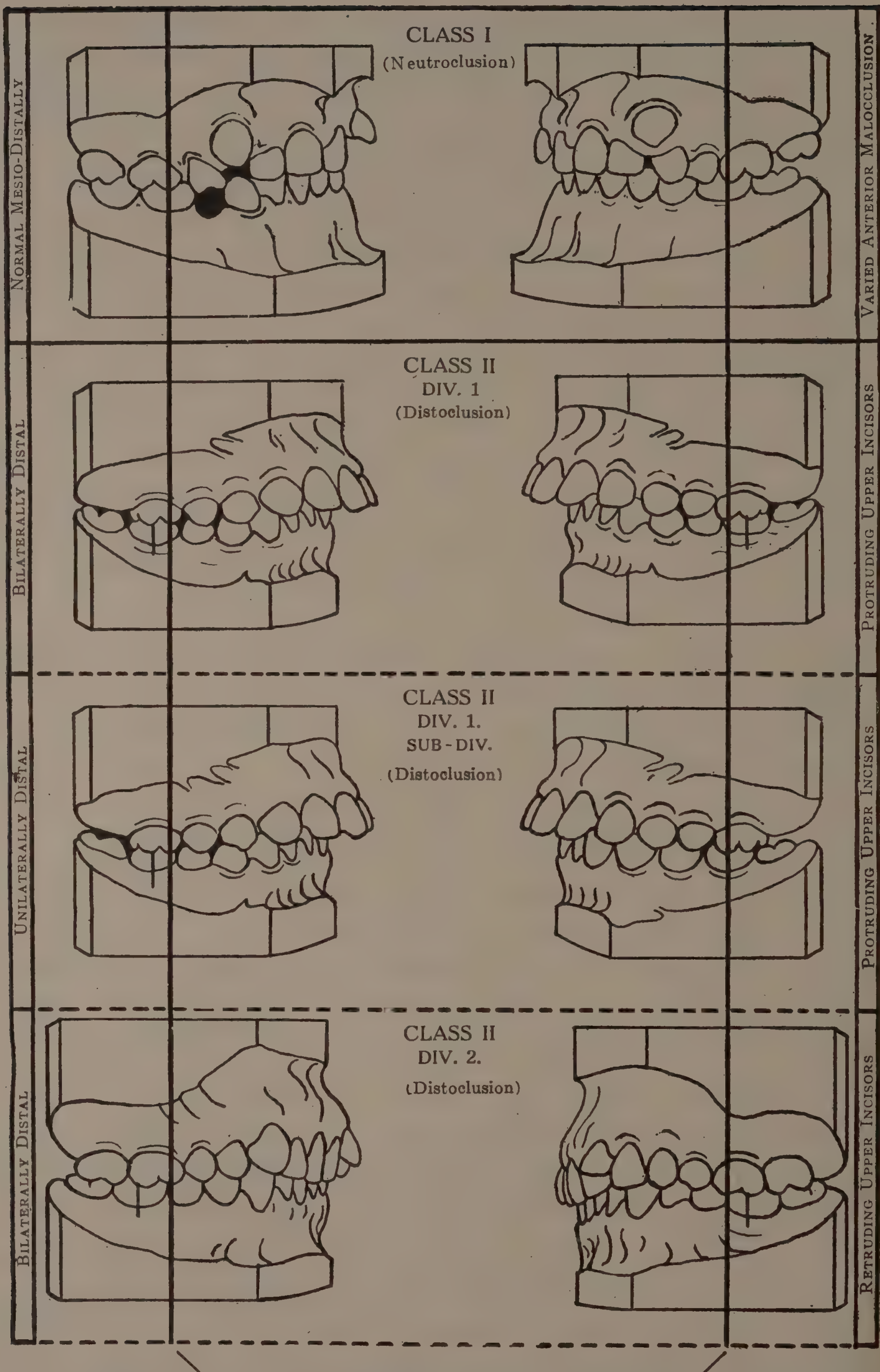


FIG. 577.—Diagnostic chart of the mesio-distal variations in malocclusion. Based upon the Angle classification.

Associated, as it usually is, with mouth-breathing, the functions of normal breathing must be restored before treatment is successful, as it is believed that mouth-breathing is the greatest causative factor in its production.

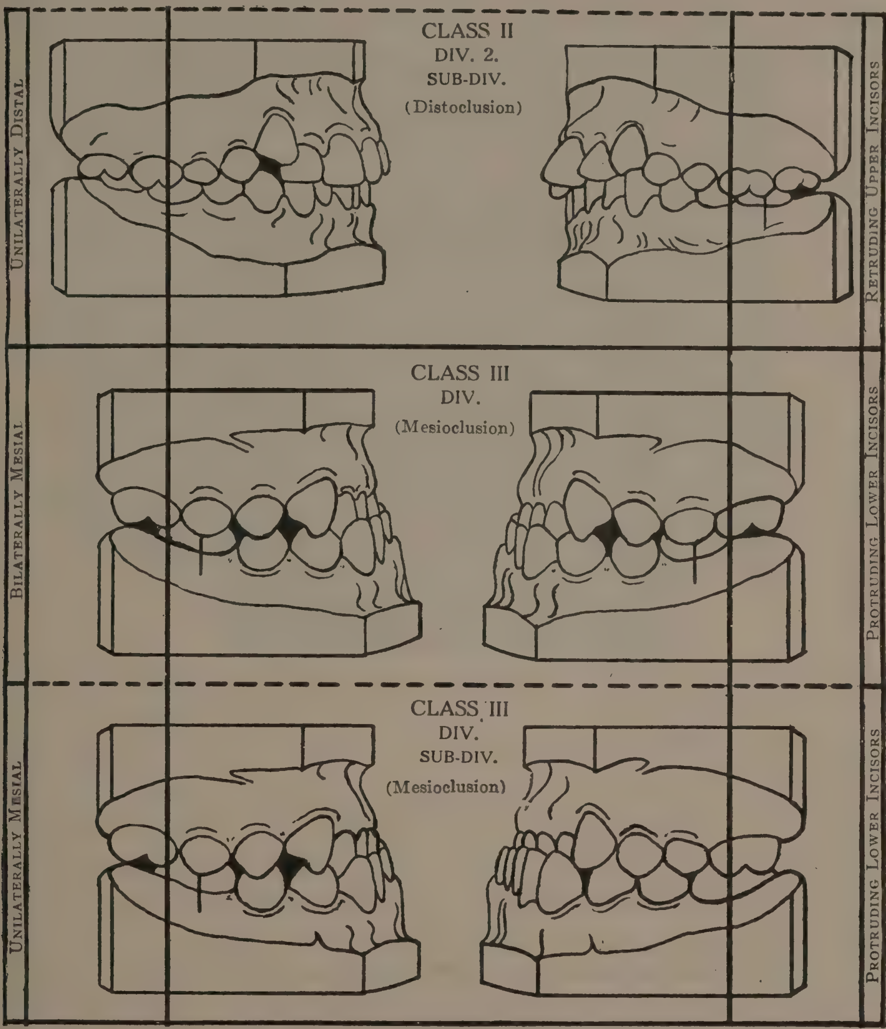


FIG. 578.—Diagnostic chart of the mesio-distal variations in malocclusion based upon the Angle classification of malocclusion. The line of diagnosis is the vertical line running through the mesio-buccal cusp of the upper first molars.

Add to this the overdevelopment of one region and the under-development of another part in the same maxillary arch, and the extent of the abnormal conditions present may be understood.

Variations of Infraversion.—Infraversion occurs in several forms, best described by the designation of the region in which it is observed, as

infraversion of incisors, cuspids and bicuspids, infraversion of bicuspids and molars, and full bimaxillary infraversion.

Infraversion of Incisors, Cuspids, and Bicuspids.—By far the most common form of infraversion is observed in the lack of occlusion of the incisors, cuspids, and bicuspids, sometimes including the first and second permanent molars, varying usually with the extent of the mouth-breathing.

It is especially characterized by lack of development of the premaxillary portion of the arches, and oftentimes overdevelopment of the posterior portion of the same arches.

FIG. 579.—Infraversion of incisors, cuspids and bicuspids.

Fig. 579 illustrates an extensive case of infraversion extending distally as far as the molar region.

Bilateral Infraversion of Bicuspids and Molars.—Extensive infraversions involving the molars and bicuspids on one or both sides, may occur in any of the various classes of malocclusion. Fig. 830 represents a case of bilateral infraversion of the molars and bicuspids, and in its mesio-distal relations, it may be classified as a Class I case.

Unilateral infraversion of molars and bicuspids is a condition more commonly observed as the result of arch mutilation through extraction, especially of the first permanent molars.

Full Bimaxillary Infraversion.—Another extensive case of infraversion, involving all of the teeth of both arches, described by Dr. Case * is worthy of especial notice.

As seen in the cast on the right of the cut, Fig. 580, the teeth, anteriorly and posteriorly, are very much too short in relation to the plane of occlusion, although being comparatively normally related mesio-distally,

* *Dental Cosmos*. December, 1905, page 1411.

and the arches quite fully developed and of normal shape. When the jaws are closed, as in the model on the left of this figure, the facial appearance is that of an edentulous mouth, with its lines of senility caused by the approximation of the nose and chin, and the unnatural fullness of the lips

FIG. 580.—Full bimaxillary infraversions. (*After Case.*)

and cheeks, as illustrated in the face mask on the left of the cut. The model and face mask on the right, the normal pose of the profile, was obtained by placing a piece of modeling compound between the teeth, and the distance between the arches of teeth adjusted until the profile appeared normal.

CHAPTER XXXVI

ETIOLOGY OF MALOCCLUSION

Deductions from Early Symptoms of Developing Malocclusion.—The establishment of diagnostic interpretations from the basis of occlusion has caused an earnest study of early symptoms of developing malocclusion, a very large percentage of cases exhibiting such peculiarities of maldevelopment of the arches as a whole, as to claim a most serious consideration of the possible etiological characteristics, and their probable bearing upon operative treatment of abnormal conditions present.

The exclusion of many local etiological factors in the production of small and crowded arches of teeth has led to the conclusion that malpositions of the teeth, individually and collectively, are but superficial symptoms of deficient or arrested function and development of the arches as a whole, including the alveolar process and underlying bone, and even extending into the associated nasal structures and sinuses.

The concomitant arrest of development of the nasal cavities, and a diagnosis of similar local or remote etiological factors, furnishes the strongest proof of the wisdom of observing and preventing abnormalities in development during the earliest period of child life, when functional insufficiency interferes most profoundly with the normal growth of developing anatomical structures.

Very marked malocclusions of the deciduous teeth, such as pronounced protrusions, have been not infrequently observed by the author and others in children of two years of age and younger, exhibiting some form of functional derangement, especially in the nose and throat, and indicating defects in development which may be of congenital origin.

These disturbances in development occur very early in life, and if remedial treatment is not instituted before the sixth or seventh year, or even earlier in some cases, the possibility of permanent benefit, especially in the establishment of normal nasal respiration, where it is perverted, is greatly lessened.

Intra-uterine Influences upon Arch Development.—The normal development of the dental arch, including the alveolar process and the deciduous and permanent teeth, preconceives primarily, the healthy structure and the molding and development of the maxilla and mandible during embryonic life, which are naturally dependent upon the nutritive and other conditions present in intra-uterine life.

It is conceded that prenatal influences, whether they be of a nutritional, functional or nervous type, have a definite bearing upon the metabolic processes which tend toward symmetry or asymmetry of development of the embryo in whole or part.

Hare-lip and cleft palate are recognized as simply lack of complete development in the embryo through some retardation in intra-uterine development, the causes for which are obscure only because of the inability to directly trace the particular influences which might arise from a neurotic or other tendency, which in turn affects the growth and development of cellular structures in those parts of the human organism peculiarly open to such influences.

Dr. Talbot remarks: "The structures of the mouth and nose being exceedingly variable in evolution, and the structures of the jaws and teeth having taken an embryonic trend for the benefit of the body as a whole, under the law of economy of growth, *disturbances of balance* are peculiarly apt to occur here." . . . . "Not only is actual growth upset by the operation of this disturbance of balance, but certain potentialities are likewise interfered with."

Whatever the particular stress may be which lowers potentiality or retards development in the embryo, it is enough to know that such influences exist, and invariably affect the development of particular parts of the organism in greater or lesser degree.

Dr. Hellman* remarks, "If we should examine the countless modifications that a developing organism passes through from inception to parturition, and realize the underlying conditions bringing about these remarkable transformations, until the completion of an individual, we shall not wonder that a malformation may appear now and then, but we shall be surprised that such disturbances are not the rule instead of the exception."

This writer calls special attention to Ballantyne's† charting of the periods of ante- and post-natal development with reference to the particular form of interference with developmental conditions which may ensue during each period.

Post-natal Factors in Arch Development.—After birth the normal development of the dental arch is largely a question of proper nutrition and function, recognizing also, the possibility of an insufficiency of nutrition and perversion of function with which the child may be born into the world, and from which inadequate foundation, normal function and normal structure are not readily developed.

Heredity and Environment.—It is believed popularly among the laity and those of the dental profession who have given the matter no

* Some Etiological Factors of Malocclusion, Milo H. Hellman, *Dental Cosmos*, Sept., 1912, p. 92.

† Manual of Antenatal Pathology and Hygiene, Ballantyne.

serious study that malocclusion of the teeth is inherited. Parents frequently make the assertion that a child inherits a protruding or receding jaw from one side of the family, and the dentist or orthodontist, without the knowledge of certain biological facts at his command, is apt to acquiesce in this assumption without qualification.

Evidence that malocclusion is inherited is lacking, and proof that it is not inherited lacks the test of experiment and further light upon this problem in biology.

However, as orthodontia is primarily a study of developmental conditions, heredity is as much concerned with it as is any other factor of development, and perhaps more so. Dr. A. Leroy Johnson, in a recent article,* says, "To ignore the fact of heredity in any study of development, normal or abnormal, is not consistent with modern scientific thought. Even though we grant that today there is no evidence of the inheritance of malocclusion, to dismiss the question of heredity, because of this, would be to leave out material that constitutes an essential part of the foundation of dental science in the study of development."

As a matter of fact modern biologists have not taken malocclusion into consideration in any studies of heredity, thus making the task of explaining malocclusal manifestations from the standpoint of heredity, or of disproving them, almost insurmountable.

A great deal of confusion exists in the popular mind today concerning heredity, due no doubt to the superficial knowledge of the subject possessed by many of the laity who do not take into account the biological principles involved.

Conklin remarks as follows: "Heredity originally meant the transmission of property from parents to children, and in the field of biology it has been defined erroneously as "the transmission of qualities or characteristics, mental or physical, from parents to offspring. The colloquial meaning of the word has led to much confusion in biology, for it carries with it the idea of transmission from one generation to the next of ownership in property. And when it is said that a son inherits his stature from his father, and his complexion from his mother, the stature and complexion are usually thought of only in their developed condition, while the great fact of development is temporarily forgotten. Of course there are no "qualities" or "characteristics" which are transmitted as such from one generation to the next."†

Walter, another teacher of biology, writes as follows: "The son resembles his father because he is a "chip off the old block." It would be still nearer the truth to say that the son resembles his father because

* Heredity, by Dr. A. Leroy Johnson, Dental Cosmos, July, 1923.
† Heredity and Environment, page 123, Edwin G. Conklin.

they are both chips from the same block, since the actual characters of parents are never transmitted to their offspring in the same way that real estate or personal property is passed on from one generation to another."

"So it comes about that "organic resemblance" between father and son, as well as that which often appears between nephew and uncle or even more remote relatives, is due not to a direct entail of the characteristics in question, but to the fact that the characteristics are "based on descent" *from a common source*. In other words, an "hereditary character" of any kind is not an entity or unit which is handed down from generation to generation, but is rather a *method of reaction* of the organism to the constellation of external environmental factors under which the organism lives."*

Orthodontia is a science in which the development of the individual organism from its inception to maturity, from "the egg to the adult" must be studied, and heredity is one of the most important factors that have to do with this development. Walter further remarks, "Three factors acting together determine the characteristics of an individual, namely, *environment, response, and heritage*. It may be said that an individual is the result of the interaction of these three factors since he may be modified by changing any one of them. Although no one factor may be omitted, the student of genetics places the emphasis upon heritage as the factor of greatest importance. . . . It is what he actually *is* even before birth. . . . It is his nature."

"Environment and response, although indispensable, are both factors which are subsequent and secondary. Environment is what the individual *has*, for example, housing, friends and enemies, or surrounding aids which may help him and obstacles which he must overcome. . . . Response, on the other hand, represents what the individual *does* with his heritage and environment. . . . Consequently, the biologist holds that, although what an individual *has* and *does* is unquestionably of great importance, particularly to the individual himself, what he *is*, is in the long run far more important."

Germplasm and Somatoplasm.—To quote Walter again, "Tyndall and others effectually demonstrated a generation ago that today living matter always arises from preceding living matter, and this conclusion is generally accepted as an axiom in genetics. . . . In primitive forms . . . continuous life is the natural order, and death, when it does occur, is, as Weissman has pointed out, accidental and quite outside the plan of nature."

"In these cases, it is easy to see the reason for "organic resemblance" between successive generations. Parent and offspring are successive

* Genetics, Herbert E. Walter.

manifestations of the *same thing*, just as the begonia plant, restored from a fragment of a begonia leaf, is simply the extension of the original plant."

"In all cases there is a *material continuity between succeeding generations*. Offspring become thus (in the asexual spores of many plants) an extension of a single parent, or (higher up in the scale of sexual organisms) of two parents, while heredity is simply "organic resemblance" based on descent."

"In forms that reproduce sexually, there occurs a differentiation of the body substance into what Weissmann terms *somatoplasm* and *germplasm*. Somatoplasm includes the body tissues, that is, the bulk of the individual, which is fated in the course of events to complete a life-cycle and die. Germplasm, on the contrary, is the immortal fragment freighted with the power to duplicate the whole organism and which, barring accident, is destined to live on and give rise to new individuals."

Thus it is evident that hereditary factors in malocclusion, if any, must come through the germplasm, while the environmental factors must be related to the somatoplasm. As Dr. Hellman remarks, "A character to be inherited must be innate in the germ cell."

Conklin* says, "*Whenever the differential cause of a character is a germinal one, the character is, by definition, inherited; whenever this differential cause is environmental the character is not inherited.* While it is true that inheritance is most clearly recognized in those characters in which offspring resemble their parents, even characters in which they differ from their parents may be inherited, as is plainly seen when, in any character, a child resembles a grandparent or a more distant ancestor more than either parent. . . . The chief characters of every living thing are inalterably fixed by heredity. . . . Many characters which are peculiar to certain individuals are known to be inherited, and in general use the word "inheritance" refers to the repetition in successive generations of such individual peculiarities."

Again, this same author sums up the matter concerning resemblances and differences in the individual as follows: "On the other hand many resemblances between parents and offspring are not due to heredity at all, but to environmental conditions. By means of experiment it is possible to distinguish between hereditary and environmental resemblances and differences, but among men, where experiments are out of the question it is often difficult or impossible to make this distinction."

The problem of variation is thus concerned with the question of heredity, and as Dr. Hellman puts it, "it is not the question of how much we differ in our makeup with each other, but rather how much we are alike in our differences."

* Heredity and Environment, pp. 64 and 65 (1920 ed.), Edwin G. Conklin.

Walter remarks, "The popular formula "like produces like" is not a rule of heredity. On the contrary, like often produces something apparently unlike. For instance, two brown-eyed parents produce a blue-eyed child, although brown-eyed children are more usual from such a parentage."

In connection with a further study of heredity, the methods of study of variations, acquired characters, *et al*, will assist the student in a better understanding of the truly biological aspect of the whole subject and enable him to keep an open mind relative to the question of heredity in its relation to malocclusion.

It has not infrequently been stated that a child has inherited the small jaws of one parent and the large teeth of the other. Belief in this idea might arise from a wrong conception of the Mendelian theory of *dominance of character* of one parent and *recession* of a character of the other parent. There is no substantial basis for this idea of heredity. As Woodruff says, "Whether a character is dominant or recessive, there is generally, if not always, harmonious development in all hybrids. In a mule, for instance, we never see the appearance of the small jaw of one parent and big teeth of the other, or *vice versa*. The big ears of the ass are dominant, but their relation to the big head is harmonious."*

Thus it is also observed that in the intermarriage of different races nature produces an harmonious type in the offspring as far as the transmission of the physical characteristics of either parent is concerned.

Mutilations of the body in respect to their inheritance might well be considered at this point, and in this connection it may be said that generations of perfectly formed children have been born from parents, one or both of whom were deformed by occupation or accident, so that heredity does not influence maldevelopment in these cases.

Disease.—In considering the possibility of the inheritance of disease Castle says, "A disease may be transmitted when the disease producing organism enters the reproductive cell, but we do not refer to such a circumstance as an instance of inheritance. In this way, syphilis is transmitted, but is not in a true sense inherited."†

In order for disease to be inherited it must be a defect of the germ cell itself and inherited in the same manner as any physiological or morphological character is inherited.

Conclusive evidence that malocclusion is inherited, *i.e.*, transferred to the germ cell and thus to a new individual has not as yet been presented, and it is well to accept with reservations any arbitrary statements to the contrary in the light of our present knowledge of the subject.

* Heredity or Environment, Chas. E. Woodruff, Items of Interest, Feb., 1915.
† Genetics and Eugenics, W. E. Castle.

Environment, however, which has been shown to be an important influential factor in the somatic changes in the organism, can to some extent be controlled. Those who are particularly intrested in the developmental possibilities of the child, such as the parents, teachers, physicians, and specialists including the orthodontist, should be cognizant of their responsibilities in theis environmental influence, and by their intelligent care and cooperation, they should so modify the environment of the child during growth and development as to exert the greatest benefit on the future welfare of the child whose environment is faulty from whatever cause.

Fig. 581.—Progressive acromegaly showing changes in the face from the ages of 24 to 42.

Etiologic Relations of Internal Secretory Organs to Malocclusion.—Recent investigations have shown that the entire chain of internal secretory organs, or ductless glands, are intimately connected with the growth of the whole body. Biedl* remarks: "The results of human pathology, especially the comparison of the clinical with the post-mortem findings, have in other directions supplied the most valuable evidence in favor of the doctrine of internal secretion. Instances are afforded by myxedema on the one hand, and by exophthalmic goiter and acromegaly on the other. These pathological conditions have supplied facts concerning the physiology of the thyroid and pituitary glands, the value of which is incalculable."

Acromegaly, which is a chronic disease characterized by overgrowth or enlargement of the bones and soft parts of the hands, feet, and face, furnishes a clinical picture of the results of hypertrophy of the pituitary body, or with disease of the thyroid. Fig. 581 illustrates a case of progessive acromegaly with suggestion of gigantism, showing the changes in the face from the age of 24 to 42. Cretinism, associated with thyroid disease, on the contrary, exhibits the inhibitory action on body growth as shown in dwarfing of the stature, idiocy, and mental dullness.

Cushing† suggests that "There are few subjects in medicine which promise a wider overlap upon the field of special workers than hypophyseal (pituitary) disease."

Thus it is that "in view of a new pathology based upon a new physiology, which recognizes the internal secretory organs," as Grieves expresses

* Biedl, Internal Secretory Organs.

† The Pituitary Body and its Disorders. Harvey Cushing.

it, the etiology of such maldevelopmental conditions as malocclusion and facial deformity should include the possible effects of disease or insufficiency of these ductless glands.

In a summary of the investigations and clinical studies of the internal secretory organs, Grieves* has pointed out the rational theory of such an etiology of malocclusion and facial deformity, through the correlation between the physiological and pathological functions of these glands. He says, "that all of these tissues (the central and sympathetic nervous systems) and glands (the internal secretory) compensate and inhibit each other in cycle, any interfering influence or disease which disturbs this coordination seriously and very diversely affects nutrition, bodily development and function according to the time at which it occurs, before or after puberty, with the most marked effects at the periods of bodily stress and change, *i.e.*, from birth to tooth eruption, the first and second dentitions, puberty and menstruation; pregnancy and lactation in the female, climacteric and senility in both sexes; that the internal secretory organs have each a special function in these important periods besides that of growth, presiding over parturition, controlling sex and sex characteristics, promoting lactation and maintaining immunity to infectious diseases in the infant, and all of this cycle is peculiarly susceptible to damage from the infectious diseases of childhood, as scarlet fever, measles, chickenpox, whooping cough, etc."

Also, "that normal development of the bones of the face and the base of the skull, the proper growth and articulation of these with the base of the skull, the growth of the nasal and post-nasal regions and accessory sinuses, and the eruption of the teeth, all depend upon the correct functioning of these organs and their correlation with the sympathetic nervous system; insufficiency or disease in any one, will interfere with the synchronism of the whole, causing various forms of deformity, as in the major expression, for instance, thyroid disease producing cretinism and myxedema, and pituitary disease producing acromegaly and giantism, all affecting facial regions, as in minor expression, glandular insufficiency producing the different forms of malocclusion and defects in the teeth and their eruption."

Grieves further points out that breast feeding by supplying activators or stimulants to action to the ductless glands has its ratio of influence in bodily growth, and bottle feeding, in its lack of supply of these same activators, has a corresponding reverse influence in inhibiting the action of these glands and retarding development, not only of the whole body, but especially of the teeth and jaws, and facial bones.

* The Relation of the Internal Secretory Organs to Malocclusion, Facial Deformity and Dental Disease, *Dental Cosmos*, Aug., 1914. Clarence J. Grieves.

Thyroid insufficiency and hypopituitarism represent enough of the derangement of function of two of these glands and consequent maldevelopment of the body so that the less known pathology of the thymus, the suprarenals, the spleen, and other ductless glands may well be considered with a view to throwing further light on the etiology of such peculiar conditions of maldevelopment as present to the orthodontist.

The science of endocrinology, which has originated from the study of the functions of the endocrine glands, has made wonderful strides in progress since the work of Beidl on the internal secretory organs was published, and a more general knowledge of the action of the hormones of the endocrine glands has been disseminated. Adrenalin, thyroxin, epinephrin, tethelin, pituitrin, and other active gland principles have been isolated and their effects under certain conditions are known.

Dr. Crosby* says, "The morphogenetic or growth-regulating properties of the endocrins are well recognized, but the present knowledge of gland therapy is in such a nebulous state that our present position must be one of watchful waiting. The most promising field in endocrinology seems to be in speeding up physical development and in hastening the eruption of tardy teeth." This writer quotes a warning from Dr. R. S. Hoskins,† in regard to endocrine therapy as follows: "The fact, and it is an incontrovertible fact, that with the change of dosage, exactly opposite effects are produced, is highly significant . . . To one class of practitioners, endocrinology betokens a mass of absurdities on a par with phrenology or mesmerism. To another class it betokens a new gospel, the light of which is destined to guide medicine to glorious heights . . . To deduce from the unfortunate existing situation, however, the conclusions, which certain shallow observers seem to have drawn, that the field of endocrinology itself is merely a mirage, is quite as crass a mistake as to accept as substance every flattering prospect the eye discerns."

Exanthematous Diseases of Childhood.—The infectious diseases of children in which eruptions or rash on the skin occur, such as scarlet fever, measles, chicken pox, etc., accompanied by high temperature, exert a more less harmful or destructive influence on other structures that are derived from the epithelium, such as the enamel of the teeth, which, however, may or may not exhibit perceptible marks from these diseases.

While it cannot be demonstrated that other structures are directly affected by these diseases, they do cause through fever or high temperatures an offset of the normal endocrine balance, and in this manner may interfere with normal growth and development of the jaws.

* Recent Literature on the Endocrin Glands, by A. W. Crosby, D.D.S., Dental Cosmos, March, 1923, page 285.

† Some Current Trends in Endocrinology, by R. S. Hoskins, M.D., *Journal of the Amer. Medical Assoc.*, Nov. 5, 1921.

Abnormal Functional Influences in Malocclusion.—After birth, the influences which tend to normal arch development are largely functional, influenced of course by environment, and any derangement of function of the jaws or associated structures of the internal face shows itself in lack of development of the dental arches.

Succeeding mammary function, which is believed to have considerable influence upon general developmental conditions in infancy, the functions of mastication and respiration, and the proper use of the muscles of the tongue, cheeks and lips, are the most important factors in the development of the dental arch after dentition is complete.

Inflammatory Changes in Alveolar Tissues.—The thickening and hardening of the cancellated and cortical portions of the alveolar process through suppurative conditions caused by diseased teeth interferes with normal and uniform development of the bony tissues in which these changes take place, and no doubt is causative of some of the peculiarities of development of the dental arches, especially of tardy eruption and tooth impaction.

Specific or Other Disease.—The influence of such diseases as syphilis, rickets, and others may seriously affect the development of the osseous structures of the maxillæ. *Syphilis* of a congenital origin has frequently been referred to as a cause of defective teeth, and is thought by many to be a cause of malocclusion of the teeth, although, except where the disease is actively persistent, it is difficult to make a differential diagnosis of the causative factor and ascribe to specific disease conditions that may have been caused by defective metabolism.

The stigmata of syphilis as noted in the mouth are exhibited by lack of, or defective enamel upon the teeth, often observed as grooves in the enamel where calcification has been interfered with. However, these enamel defects are so often caused by the febrile disturbances of children that it is unsafe to lay any stress upon these conditions as being diagnostic of specific disease unless there is more direct evidence of it.

If the family history can be obtained and evidences of specific disease positively determined, aided by Wasserman and other tests, then and then only can the diagnosis of syphilis be made with any degree of certainty. The absence of teeth, while not necessarily of syphilitic origin, is often ascribed to congenital syphilis.

Rachitis, familiarly known as rickets, is a disease, usually occurring in childhood in which there is a softening of the bony tissues of the body due to a lack of calcification, probably an unbalanced endocrine condition, in which the calcium salts are deficient. Occurring usually in the growing period of childhood its effects are usually noted in an enlargement and abnormality of the bones of the head often with a disappearance of the

angle of the mandible and the elongation and thickening of the body of the mandible, together with malocclusion of the teeth.

Pyorrhea.—Malocclusion is often a result of pyorrhea, the teeth becoming elongated, and forced into malpositions through the undue influence of their own inclined planes.

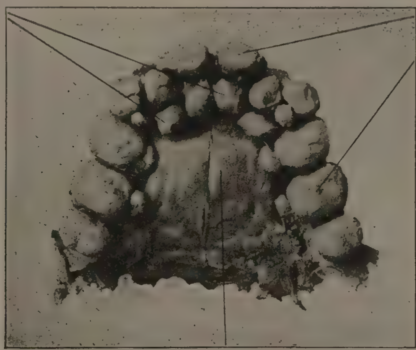


FIG. 582.—Tooth-follicles for deciduous and permanent teeth three months after birth. (*Broomell.*)

Abnormal Muscular Action.—As illustrative of the effect of abnormal muscular action upon the development of bone in the maxilla and mandible, the lines of stress in developing bone caused by muscular action as seen with the X-ray by Walkhoff, offer sufficient evidence of the influence of muscular action in development, not only in embryo and infancy, but also during the entire period of development of the dental arches up to the time of the eruption of the last permanent tooth.

This investigator has demonstrated conclusively that the stress upon the surface of the bone through the muscular attachments was directly related to the internal development of and arrangement of the bone spicules, which form themselves in lines parallel to the direction of the exertion of the muscular force upon the external surface of the bone.

Disuse of the muscles of mastication, or their abnormal use, therefore, must have its effect in the deficiency and abnormality of development in the dental arches. The disappearance of the angle formed by the rami and body of the mandible in certain pronounced mouth-breathers of Class III is an evidence of the influence of abnormal muscular action upon the shape of the underlying bone.

Abnormal Arch Development.—In consideration of the factors which tend to arrest or retard dental arch development which have been stated, it is interesting to note the positions of the permanent tooth follicles at a period in child life when the deciduous teeth are unerupted, and speculate

upon the possibilities of arrested development upon the permanent arches of teeth.

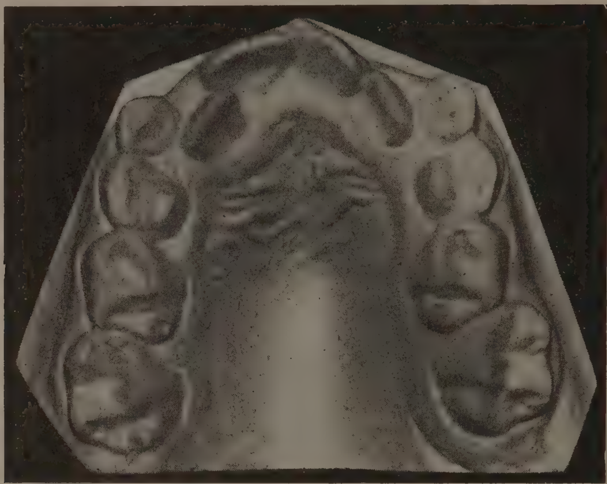


FIG. 583.—Upper cast of child of seven years.

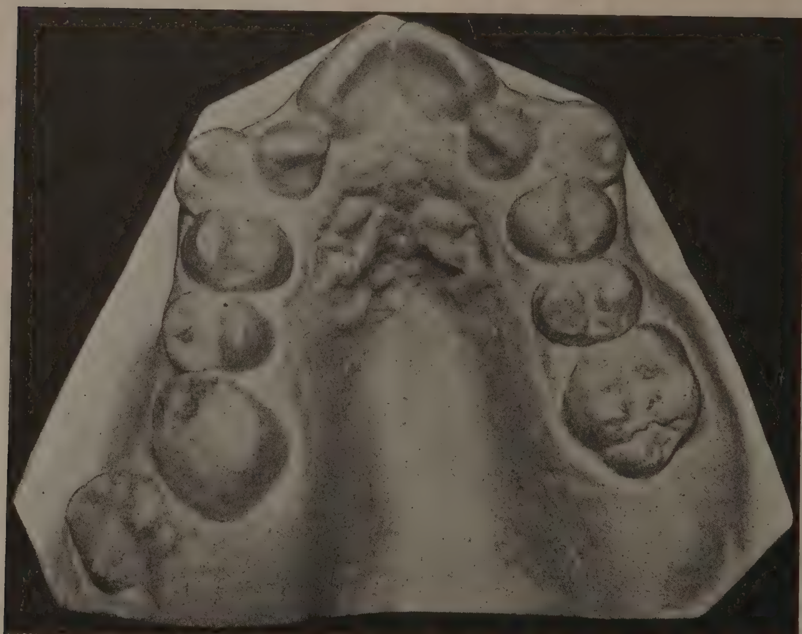


FIG. 584.—Upper cast of adult of twenty-seven years.

Fig. 582 represents the dissected tooth follicles of the deciduous and permanent teeth in the mouth of a child three months after birth, the plastic tissues in the center of the cut being the periosteum covering the

hard palate, the tooth follicles being imbedded and firmly adherent to the fibrous tissues laterally and anteriorly.

The tooth sacs of the deciduous teeth are upon the periphery, being external to, and larger than the sacs of the permanent teeth. The arch of the deciduous teeth, which are nearly ready for eruption anteriorly, is very nearly uniform in shape and development, while that of the permanent teeth has not at this age even assumed any definiteness in the uniformity or position of its teeth, the four permanent incisors being more fully developed than the cuspids and bicuspids, but the lingual position

FIG. 585.—Photo of child of four years.

FIG. 586.—Matured face of child in Fig. 585. Age 27.

of the laterals indicates that considerable *arch development* must take place before there will be sufficient space for these teeth to erupt into their normal positions in line with the centrals.

If, by reason of any infantile cachexia, such as malnutrition, from whatever cause, arrest of arch development should occur at this age, or even later up to five or six years of age, the resultant effect upon the arch of the permanent teeth might be such as is illustrated in the two casts shown in Figs. 583 and 584 at the ages of seven and twenty-seven, in which the positions of the central and lateral incisors are seen to be almost identical with those of the permanent incisor follicles in Fig. 582.

It will be observed that the adult arch in Fig. 584 did not develop any larger than the arch of the deciduous teeth in Fig. 583, the arrest of development being almost permanent except for the eruption of the permanent teeth into positions of irregularity, so great was the functional

disturbance which left its impress upon the maxilla and overlying processes.

Another interesting feature about the case of this adult is that there was no apparent facial deformity except the slightly marked deviation of

FIG. 587.—Comparison of casts of four years (upper) and ten years (lower) showing lack of growth in latter.

the central facial line at the age of four, see Fig. 585, but at the age of twenty-seven, Fig. 586, the distortion of the facial lines indicates serious malocclusion and maldevelopment.

Again, in Fig. 587, is observed the upper deciduous arch of a four year old child, and the undeveloped upper arch of a ten year old child. The feature of striking interest in the case is the fact that the arch of the ten year old child is scarcely larger and is not more developed than that of the child of four with which it is compared.

Such studies as these prove to the observer that, although the function of occlusion is perverted, and its beneficial influence upon the growth of the dental arches lacking, there are still present causative factors of the arrested development, of either prenatal or post-natal origin, which must be given due consideration.

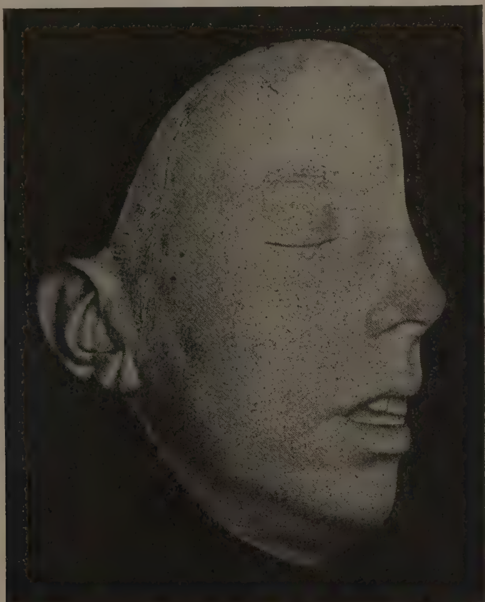


FIG. 588.—Face mask of typical mouth-breather.

Mouth-breathing.—One of the most serious abnormal conditions with which the rhinologist and the orthodontist have to deal, and one as intimately connected with the disturbance of normal function and structure in the field of the one as in that of the other, is the partial or complete loss of normal respiratory function through the obstruction of the nasal, naso-pharyngeal, and oro-pharyngeal air passages, causing oral respiration, commonly known as mouth-breathing.

That this condition, with all of its injurious results upon the development of the bones of the head and face, the disfiguring of the features, and the undermining of the general health, is becoming more prevalent, one hardly needs statistics to show, in view of the great numbers of those afflicted with this trouble in all walks of life.

Fig. 588 represents the face mask of a typical mouth-breather, the characteristic features noticeable being the open and drooping mouth, the short upper lip, the undeveloped nose and undilated nostril, and the malocclusion of the teeth. The vacant stare especially accompanies the presence of large adenoids, and is said to be caused chiefly by the stagnation of lymph at the base of the skull.

On examination of the relations of the arches of teeth, Fig. 589, of the patient whose face mask is illustrated in the previous figure, it will be noticed that arrested and abnormal development of the arches of teeth is in evidence, sufficient to cause a very great lack of harmony of the facial lines. The upper arch is narrow and elongated, the upper bicuspids and

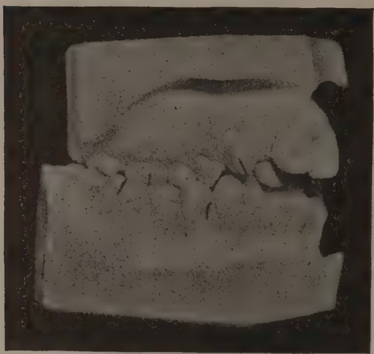


Fig. 589.—Cast of mouth-breather shown in Fig. 588.

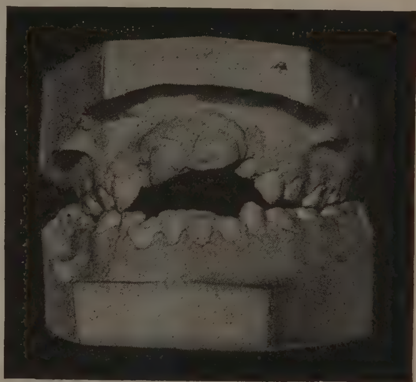


Fig. 590.—Infraversion associated with mouth breathing.

molars being in lingual occlusion, and the lower arch distal to its normal position, a case of the first division of Class II, Angle's classification.

It has been the observation of the author that a mouth-breather may present a malocclusion of any one of the different classes into which it is possible to divide the abnormal relations of occlusion, rather than of only one or two of them, as has been suggested by some writers. The shapes of the arches of teeth are varied, also, and the extent of the malocclusion measured somewhat by the degree to which oral respiration is resorted to.

One of the most aggravating forms of malocclusion associated with mouth-breathing is that of the "open-bite" malocclusion, as it has been termed by some writers. Lack of anterior occlusion and "infraversion" are similar designations for the same condition. Fig. 590 illustrates such a case belonging to Class I. There is a noticeable lack of development of both arches in this case, there being insufficient growth for

the eruption of the permanent teeth, especially in the incisor region. Fig. 591 exhibits a very common form of malocclusion, of Class II, Div. 1, found among mouth-breathers, the lower arch being distal to normal in occlusion, and the shortness of the upper lip, and therefore lack of func-

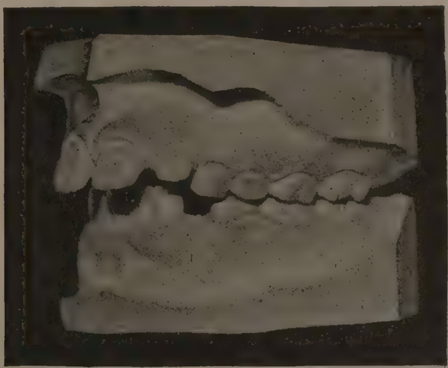


FIG. 591.—Casts of teeth of mouth-breather of Class II, Div. I.

tion in supporting the incisors, allowing them to protrude to a considerable extent, a condition which is intensified by the lower lip adjusting itself between the upper and lower incisors and forcing the upper incisors still farther forward, and further aggravated by the wrong tension of the

FIG. 592.—Mouth-breather at six months.

FIG. 593.—Same child as in Fig. 592 at seven years.

muscles of the upper lip over the canine region. A very similar inharmony of occlusion of the anterior teeth and disfigurement of facial lines is often seen in the protrusions of Class I.

It is believed that the distal position of the lower arch in cases of this class is caused primarily by the lack of lateral development of the upper

arch, because development of the upper arch in the early treatment of these cases often restores the normal relations of occlusion in the molar region, by allowing a farther forward position of the mandible without cusp interference.

Figs. 592 and 593 represent a mouth-breather at the ages of six months and seven years respectively, and it will be noted that the open and drooping mouth and other symptoms are plainly noticeable in both pictures, showing that the mouth-breathing was of early origin, and had persisted and become more aggravated in its symptoms as the child grew older.

The casts of the child's teeth in occlusion in Fig. 594 exhibit a malocclusion of Class II, Div. 1 (Angle). Both arches are contracted and

Fig. 594.—Casts of mouth-breather in Fig. 593.

undeveloped, there being insufficient space for the eruption of the upper and lower lateral incisors, and in addition, the lack of anterior occlusion.

Mouth-breathing is usually regarded as a habit, but in reality is a necessity, because of the inability to breathe properly through the nose, there being a lack of development of full nasal space, or inflammatory conditions, or some impediment in the nasal tract which will not allow sufficient air to pass through.

Obstructions to Nasal Breathing.—Among the various obstructions to nasal breathing may be mentioned deflection of the nasal septum, hypertrophied tonsils and turbinate bones, adenoids, and the diseased conditions resulting from syphilis, tumors, polypi, and cysts.

"If the nasal and post-nasal passages are unobstructed, every inspiration empties the ethmoid veins and through them the longitudinal sinus and cavernous plexus. When there is obstruction to nasal respiration, the circulation at the base of the skull is interfered with, and a long train

of ills brought about which interferes very greatly with the health of the individual. In the first place, the quantity of air aspirated through the mouth in a case of nasal obstruction is not equal to that of normal nasal respiration, and the system suffers from lack of sufficient oxygenation" (Grünwald).

Ziem's experiments in producing nasal stenosis in young animals by occluding one-half of the nose artificially, with the result of producing asymmetrical development of the two sides of the nose and adjacent

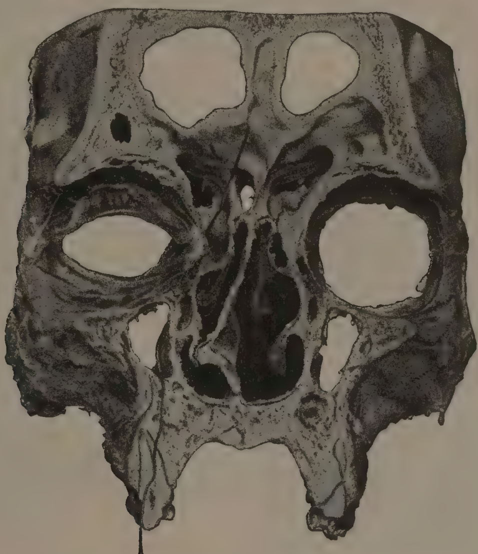


Fig. 595.—Deviation of nasal septum. (*Cryer.*)

bony tissues, the obstructed half being arrested in development, as well as the contiguous tissues on that side of the face, are worthy of note as proof of the correctness of the theory that nasal obstruction is causative of arrest of development in the human head and face.

It is important that the diagnosis of the obstruction of the air passages should be made as early as possible after its incipiency, so that by proper treatment and operation, if necessary, normal development may not be more seriously interfered with, and the health of the child seriously impaired. There are so many local symptoms of this abnormal condition that even the novice ought to be able to diagnose it.

Vocalization is impaired, especially in the pronunciation of the letters *m* and *n*, which, in the muffled voice of the mouth-breather sound like *b*.

A persistent catarrhal condition, often mistaken by parents for an ordinary cold, together with an unusual dryness of the pharyngeal mucous

membrane, and the continued drooping open of the mouth, ought to give warning of the beginning of serious nasal obstruction.

If allowed to continue, deficient nasal respiration may be causative of arrested development, not only in the face and head, but in other parts of the body, insufficient oxygenation causing anemic conditions of the general system, the dulling of the mental faculties, and a favorable opportunity for the inception of infectious diseases, especially tuberculosis.

Deviation of Nasal Septum.—In the normal subject the nasal septum occupies a position in the nasal cavity dividing one-half of the nose from the other. Slight deviations are frequently seen in people who are not troubled with nasal stenosis to any degree, but where there is an extensive deviation from the median line, occlusion of the deviated side occurs, with consequent deficient nasal and enforced mouth-breathing. Fig. 574 illustrates a skull section in which the nasal septum is in its normal median position, the choanæ on each side being equal in size.

Fig. 595 portrays a marked deviation of the septum to the right. The choana on the side toward which the septum is deflected is very much smaller than the other, and must have been almost completely occluded during life, and there is every reason to believe that the subject was a mouth-breather.

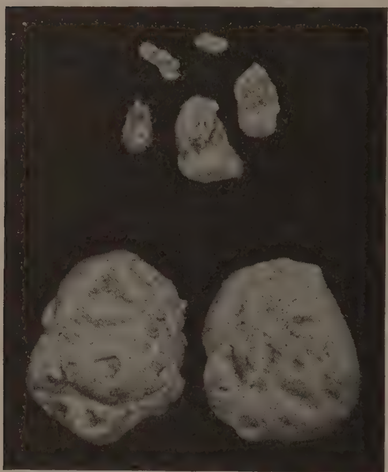


FIG. 596.—Hypertrophied tonsils and adenoids after removal.

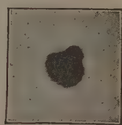


FIG. 597.—Portion of inferior turbinate after removal.

Operations for the straightening or partial removal of the septum when deflected, are of common occurrence, and are usually followed by immediate relief in cases of deficient nasal respiration.

Hypertrophy of Faucial Tonsils.—Another cause of nasal stenosis is the hypertrophy of the faucial tonsils, and from the frequency with which operations for their removal are performed, their diseased condition and obstruction to nasal breathing cannot be judged uncommon.

The faucial tonsils are frequently the seat of infection and disease because of a hypertrophied condition and improper performance of function.

The large globular masses of tissue in Fig. 596 are the faucial tonsils removed from the throat of a two year old child and were so hypertrophied that they nearly occluded the throat.

Hypertrophy of the turbinate bones, especially the inferior, is not an infrequent cause of nasal stenosis, and consequent mouth-breathing. Fig. 597 exhibits a portion of the inferior turbinate which was removed from the nose of a patient who was suffering from partial nasal stenosis.

Adenoids.—One of the most common causes of mouth-breathing is found in the hypertrophy of the pharyngeal, or Luschka's tonsil, which is situated in the vault of the naso-pharynx, usually just out of sight above the uvula.

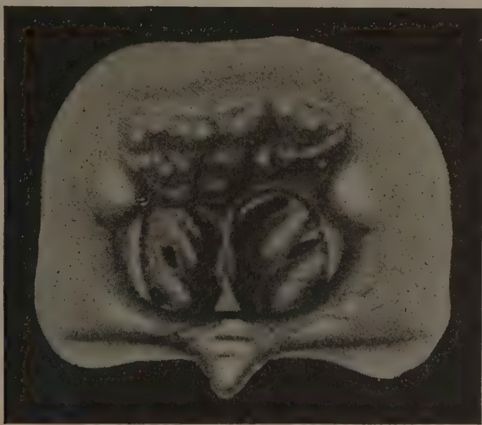


FIG. 598.—Location of adenoid tissue in the vault of the nasopharynx.

A mass of this enlarged glandular tissue may be seen in Fig. 598, being a posterior rhinoscopic view of the naso-pharynx, and it can be readily understood that the naso-pharyngeal passages may become partially occluded by the downward growth of this tissue.

Dr. Parke Lewis has called attention to the possibility of impairment of function of nutritive vessels passing through the carotid canal (which bears the carotid artery, the superior cervical sympathetic and the lymphatics) through the pressure of adventitious growths in the naso-pharynx upon the tissues which pass through the foremen lacerum medium, which is immediately above the site occupied by the adenoid tissues, and which opens into the carotid canal.

The conclusions of Dr. Parke Lewis are based upon those of Sajous in regard to the control of all oxygenation processes in the body through the pituitary bodies, which are very closely associated with the nutrient vessels passing through the carotid canal.

Sajous' Theory.—Sajous indicates the significance of these organs and their physiological and pathological importance in this connection as follows: "It will be apparent that any lesion capable of blocking the afferent and efferent impulses that traverse it at all times, and which represent the aggregate of the organism, inciting and governing energy, must necessarily compromise life, or the functions of an organ to which the blocked nerves are distributed."

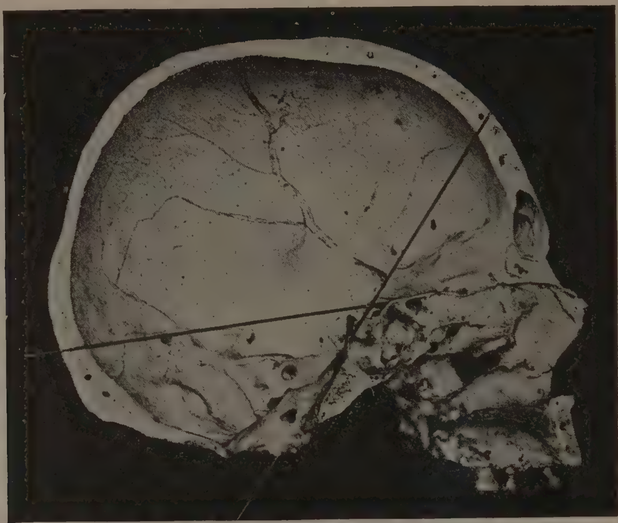


Fig. 599.—Location of pituitary body at intersection of probes.

"The large mortality under chloroform in adenectomy is in all probability due to the shock conveyed to the posterior pituitary body through the foramen lacerum medium immediately over the lymphatic enlargements."

"It will readily be seen, therefore, that whatever interferes with the nutritive functions at the vault of the pharynx may disturb the subsequent development of the whole skull and its contents."

The very close relationship which exists between the tissues of the pharynx, and the nutritive vessels of the carotid canal may be seen from observation of the position and direction of the more nearly vertical of the two probes passing through the skull section in Fig. 599, it being passed through the foramen lacerum medium and emerging into the space occupied by the pituitary body. The inferior opening of the foramen lacerum medium is in the adenoid region, and the vessels which enter it are very apt to be impinged upon by hypertrophy of the pharyngeal tonsils, and the nutrient and nerve supply to the pituitary bodies cut off enough to materially affect the proper performance of the functions of these organs, with

consequent disturbance of development of the whole skull and its contents, as well as that of the entire organism.

The horizontal probe in Fig. 599 passes through the optic foramen into the space occupied by the pituitary bodies, illustrating the very close relationship between the vessels of the eye and the pituitaries, and suggesting the probability of visual defects and insufficiencies from hypertrophied tissues in the naso-pharynx.

Dr. Eugene Talbot,* in one of his articles, also notes the possible influence of the pituitary body on the growth of the palate and of bone. He says, "In dealing with the development of the palate, both pre- and post-congenitally, the relations of the hypophysis, or pituitary body, have to be taken into account, since it has been well demonstrated that this body exerts an influence over body growth and the structures thereto related." . . . . "Strain on the development of the hypophysis after birth can not only produce undue growth of bone, but can also check development of it."

Removal of Adventitious Growths.—Granting that the theory of pressure from the impingement of adventitious growths in the pharynx upon the nutrient vessels and nerve supply of the pituitaries has not been really demonstrated, it would hardly seem to be necessary to argue the necessity of the removal of all nasal and post-nasal obstructions to nasal respiration in connection with the early treatment of malocclusion, thus promoting normal developmental conditions before the period of normal and rapid growth has passed, and choosing the opportunity of greatest benefit to the patient.

Irreparable damage may be done by the neglect to observe the early symptoms of nasal obstruction, and by the failure to place the patient in the hands of a competent rhinologist for operative treatment.

The operation for the removal of post-nasal obstructions is a comparatively slight one, some cases not always requiring the use of a general anesthetic, although where the faucial tonsils as well as the adenoids are to be removed, the more thorough surgery in this region is assured under general anesthesia.

Fig. 600 represents the very characteristic expression of a mouth-breather of four years of age, who later, at the age of seven, was brought to the author for treatment of malocclusion.

The segregated mass of tonsillar and adenoid tissue shown in Fig. 601 was removed from the naso-pharynx of this patient by a rhinologist, before treatment of the malocclusion was instituted.

A diagnosis of the malocclusion revealed the mesioclusion of the lower arch of teeth as seen in Fig. 925, and the restoration of the normal

* Etiology of Cleft Palate, Dr. Eugene Talbot, Sec. V, Page 195; Trans. Fourth Internat. Dental Congress.

mesio-distal relations of the arches resulted in the change of occlusion noted in Fig. 926, the operation being performed entirely upon the decidu-

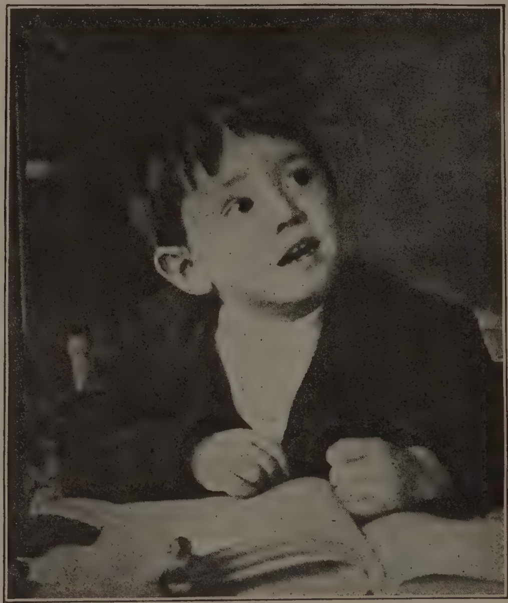


FIG. 600.—Mouth-breather at four years of age.

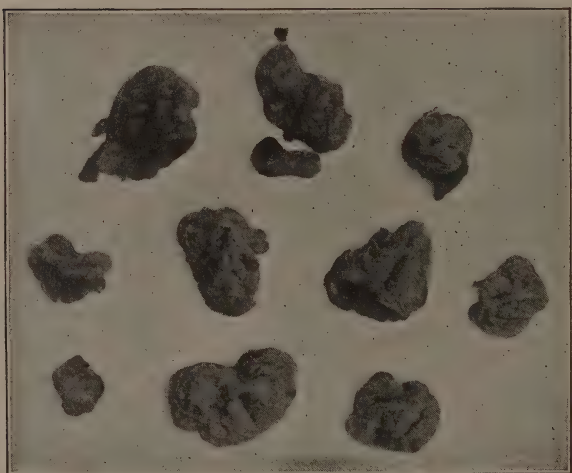


FIG. 601.—Tonsillar and adenoid tissue removed from mouth-breather in Fig. 600.

ous teeth. The change in the appearance of the boy's face from the mouth-breather in Fig. 602, with his features all distorted in his efforts to

close the mouth, to the calm, peaceful facial lines after the removal of these obstructing growths and correction of the malocclusion, in Fig. 603, indicates the advantage gained by early operating in this class of cases.

The development of this face along normal lines of growth is now assured and there is nothing left undone except training of the facial muscles to insure the very best results in the restoration of facial harmony and normal respiration, and consequently the attainment of proper physical development which in this case, was already deficient.

FIG. 602.—Mouth-breather in Fig. 600 before treatment.

FIG. 603.—Mouth-breather in Fig. 600 after treatment.

Mechanical assistance in holding the mouth closed after removal of nasal obstructions and correction of malocclusion, such as the wearing of head bandages and mouth plasters, is sometimes beneficial in the treatment.

Irremediable harm is done by the oft repeated advice to "wait until the permanent teeth are all erupted before beginning operations for correction of malocclusion," and even greater damage may be done by the neglect to observe the early symptoms of nasal obstruction, and the immediate reference of the patient to a competent rhinologist for operative treatment.

Deformed arches of teeth and disfigured features become confirmed in their abnormality after a long period of abnormal development, and neither the local tissues nor the general system will respond to remedial measures to anything like the degree that they would had they been operated on at an early age.

The head contains the portals of the human body, and it should be the duty of the orthodontist to guard against any ill effects to the health through the neglect of the oral cavity, its teeth, and related structures of nose and throat. Mouth-breathing, especially, should be prevented by such means as are at one's command, with the aid of the rhinologist, and the correction of such resulting defects in occlusion of the teeth and inharmony of the facial lines as may be necessary at the time the case presents with the symptoms of nasal stenosis.

CHAPTER XXXVII

ETIOLOGY OF MALOCCLUSION—CONT'D.

LOCAL CAUSES OF MALOCCLUSION

In contradistinction to the constitutional causes of malocclusion as discussed in the last chapter, attention must be directed to the so-called local causes of malocclusion, or those which seem to be more directly active in the oral cavity. Many of these local causative factors, however, when carefully analyzed, will be seen to be local expressions of a constitutional cause, as for example, in the cases of the local expressions of supernumerary or missing teeth, in each of which cases, while the forces of occlusion are interfered with locally causing malocclusion, a deeper underlying cause for these anomalous conditions as well as for some of the other local etiological factors is evident.

Fig. 604.—Prolonged retention of deciduous teeth.

The so-called local causes of malocclusion may be enumerated as follows: Prolonged retention of deciduous teeth, premature loss of deciduous teeth, caries, imperfect contour of fillings and crowns, delayed eruption of permanent teeth, loss of the permanent teeth by extraction or disease, supernumerary teeth, congenitally absent teeth, misshaped teeth, transposed teeth, abnormal frenum labium, and habits of thumb sucking, lip, cheek, and tongue biting.

Prolonged Retention of Deciduous Teeth.—The retention of a deciduous tooth beyond the time for its natural loss through absorption of its roots forms a mechanical barrier to the normal eruption of its permanent successor, which is deflected labially, buccally, or lingually. The permanent central incisors in Fig. 604 were deflected lingually through the prolonged retention of the deciduous centrals, the roots of which did not absorb.

As soon as these conditions are observed, the deciduous teeth which have been retained beyond the time for their natural loss should be extracted, and the permanent teeth which have been deflected, assisted into normal positions in the arch. The cause of the delayed absorption of

the roots of the deciduous teeth in these cases is due to some constitutional deficiency which thus relates the local factor to a constitutional cause, although the latter is obscure.

Premature Loss of Deciduous Teeth.—One of the prolific secondary causes of malocclusion and lack of arch development is the premature loss of the deciduous teeth, especially of the incisors and cuspids. That the mechanical influence of the deciduous teeth in assisting in the development of the arch is a necessity up to the time when natural absorption of the roots of the deciduous teeth should take place, one has only to observe the contraction of the spaces occupied by prematurely lost deciduous teeth to readily understand. Here, again, the local factor of early absorption of the roots of the deciduous teeth is secondary to the constitutional deficiency causative of the premature absorption of the roots of the deciduous teeth.

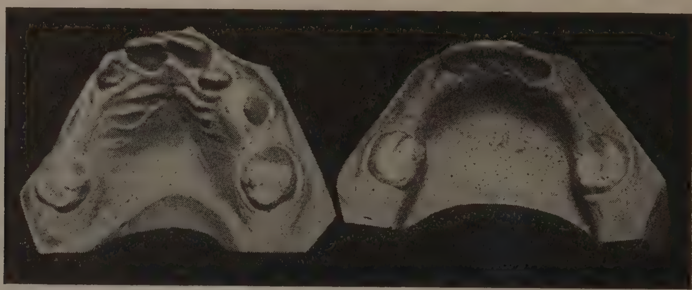


Fig. 605.—Premature extraction of all deciduous teeth.

An illustration of the retarded development caused by the premature extraction of all deciduous teeth at eight years of age may be seen in Fig. 605. It is easy to prognosticate a serious malocclusion upon the eruption of the remaining permanent teeth.

Caries.—The loss of the approximal surfaces of the deciduous teeth by caries is causative of lack of arch development through the loss of the mechanical influence of the deciduous teeth in their entire mesio-distal diameters, and such carious conditions should be observed in their earliest stages and fillings inserted to restore full approximal contour. The loss of contour mesio-distally of any of the permanent teeth through caries is likewise causative of malocclusion by causing inharmony in the size of the dental arches to just the extent of the lost contour and proximate contact.

Imperfect Contour of Fillings and Crowns.—A great many malocclusions, including some of the most severe, are caused by the under or over contour of dental restorations such as fillings, inlays, and crowns, which interfere with the normal proximate contact or disturb the normal influence of the inclined planes. Invariably, when the mesio-distal contour of a tooth is not fully restored in an attempted dental restoration, the

partial loss of the proximate contact destroys to this extent the integrity of the dental arches through the contraction of the dental arch in which the deficient contour is established, thus causing a disharmony in the relation of the opposing dental arch, and consequent malocclusion to a degree proportionate to the extent of the deficiency in contour of the dental restoration.

Again, under or over contour, or abnormal contour of occlusal restorations in the form of filling or crowns will cause malocclusion through the destruction of the normal influence of the inclined planes and the consequent malpositions of certain of the teeth from the abnormal application of force.

The responsibility of the dentist is therefore very great, for unless he realizes that the laws of occlusion are the basis of all dental restorations, he will signally fail to perform the highest service to his patients, and will do them more harm than good through ignorance of these foundation principles.

Delayed Eruption of Permanent Teeth.—One of the more frequent local factors in malocclusion is that of the late eruption of permanent teeth after their deciduous predecessors have been shed, often being delayed for months, and occasionally for years, especially if the space for their eruption has been encroached upon by the teeth mesial and distal to them. The cuspids are more frequently delayed in eruption than any other of the permanent teeth, although the bicuspids are often tardy in eruption, and occasionally the incisors.

When through lack of sufficient space for eruption or other cause a permanent tooth is prevented from erupting until its space in the arch has been developed it may be said to be impacted. Occasionally the cuspids are impacted lingually, not necessarily because of the lack of space for their eruption, but from displacement of the tooth germs, so that surgical as well as orthodontic procedure is necessary to release and restore them to proper positions in the arch.

The loss of permanent teeth through extraction or disease, by destroying arch integrity, is another frequent cause of malocclusion, which is considered in the chapter on, "The Problem of Extraction."

Supernumerary Teeth.—Supernumerary teeth are occasionally found in the mouth, and are often of the peg-shaped variety shown in Fig. 606, occasionally presenting with several irregular cusps, although sometimes resembling an adjacent normally developed tooth to such an extent that an X-ray diagnosis is necessary to differentiate between them. Their removal is usually indicated, and the restoration to normal position of the teeth which have been forced out of their alignment. The etiological factor in the case of supernumerary teeth is one that concerns the early

development of epithelial structures and hence is of constitutional origin, although local in expression.

Congenitally Absent Teeth.—The congenital absence of the tooth germ of any of the permanent teeth is an occasional cause of malocclusion through the destruction of arch integrity and unbalancing of the forces of occlusion. While the absence of any tooth is a local factor in malocclusion the indirect cause is constitutional rather than local.

Upper lateral incisors are more frequently found missing than any of the other teeth, the bicuspids of either arch, especially of the lower, being next in frequency of absence from the dental arch. The absence of one

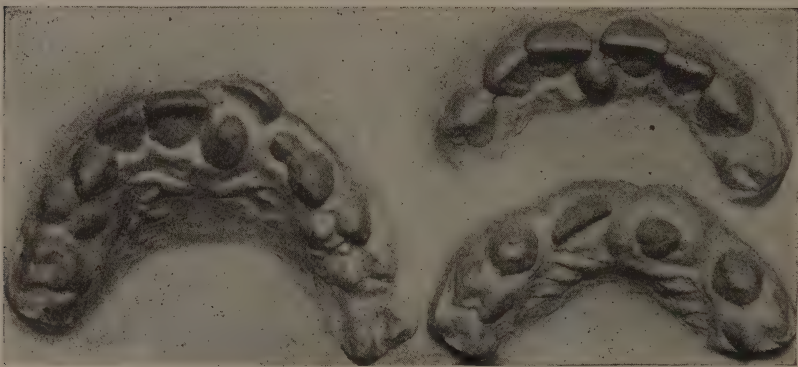


FIG. 606.—Supernumerary teeth.

or more of these teeth causes the lack of development of the dental arch in which they are missing to just the extent of their mesio-distal diameters when their arch positions are completely closed up, and hence the malocclusion may be of differing degrees of severity, according to the conditions of the individual case.

Misshaped Teeth.—An occasional cause of disharmony in the size of a dental arch is the malformation of a tooth before eruption so that if it is abnormally small, the dental arch is made smaller and if abnormally large, the dental arch is made larger, than normal. Some of these abnormally shaped teeth appear as if they had been placed under pressure and distorted, even the cusps being malformed and the influence of their inclined planes destroyed. Whatever the cause of these malformed teeth may be it is related to the constitutional rather the local factors of an obscure nature.

Transposed Teeth.—A rather infrequent local manifestation of malocclusion is found in the transposition of certain teeth so that they appear as if they had changed positions with other teeth in the same dental arch. The cuspid and lateral and the cuspid and first bicuspid are more frequently observed in transposed positions than any of the other

teeth. The attempt to reverse the transposed positions of these teeth is hardly practical, although the author was successful in doing so in a case of partial transposition of a cuspid and lateral incisor.

Abnormal Frenum Labium.—The abnormal attachment of the frenum labium sometimes causes the separation of the upper central incisors, acting as a rubber cushion to force these two teeth apart. Cases of this character are somewhat difficult to treat, although operative measures are now seldom resorted to for the partial removal of the ligament.

Thumb-sucking and Lip-biting.—The habits of thumb-sucking, lip and tongue biting are responsible for the inception of some malocclusions, and for the aggravation of a very great many cases, with other primary causative factors.

Thumb-sucking is not as frequent a causative factor in malocclusion as is generally supposed, but that it does affect the development of the arch is certain. Usually, but one side of the mouth is affected, according to which thumb is used, although it is not uncommon to find that the thumb is held in the center of the mouth protruding the upper central incisors. When the thumb is held on either side of the center, the upper incisors on the side in which the habit is induced are protruded.

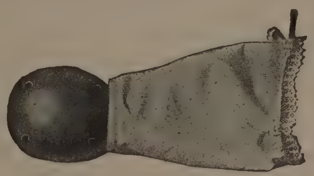


FIG. 607.—Aluminum mit for prevention of thumb-sucking.

In Class I and II cases in which the upper incisors are protruded, the habit of biting the lower lip has a pernicious influence in increasing the extent of the malocclusion, and in some cases is believed to be the initial cause of the abnormal occlusal relations.

The inculcation of a similar habit with the tongue is productive of more or less deviations from the normal in occlusal relations, and the observance of any of these habits by the parent or dentist should be followed by efforts on their part to overcome the habit and the damage already done.

A very practical method of preventing a child from sucking the thumb is to enclose its hands in polished aluminum balls, such as is shown in Fig. 607, an attachment being made by a sleeve to the child's arm, and worn as much of the time as possible, especially at night, until the habit is broken up.

The wearing of a simple apparatus of this kind will enable the child to use its arms, yet at the same time, prevent the possibility of getting the fingers or thumbs into the mouth and is much more humane than tying the arms. The balls are ventilated by several small holes, and the sleeve and ball may be easily sterilized by boiling.

CHAPTER XXXVIII

DIAGNOSIS OF MALOCCLUSION

General Considerations.—Diagnosis in orthodontia, as in general medicine, should deal first with a survey of the general health of the individual, and in orthodontia the child being the usual subject, a history of its growth and development with records of various periods of disease and their effect upon the body as a whole and their relation to the maldevelopment of the dental arches and occlusion should be obtained.

The history of bottle or breast feeding and of the growth of the child during the earliest years of infancy should be secured. The history of the parents should be inquired into to some extent and the possible influences of parental disease analyzed in respect to the form, features and malocclusion of the child.

Childhood diseases, rickets, et al, are carefully noted and their effect in causing retardation of development of the dental arches determined if possible.

The height and weight should be noted and compared with the average weight for the normal child of the same age.

Symptoms of disturbance of the internal secretory organs, while apparently rare in orthodontic patients, should be looked for, and the possible effect of endocrine disturbance upon the growth the dental arches determined.

The mental qualities should also be observed, and if the child is subnormal to any degree, the advisability of orthodontic treatment should be questioned.

All possible causes of malocclusion should be inquired into from the constitutional rather than the local aspect, as malocclusion of the teeth is usually symptomatic of a systemic disturbance of greater or lesser degree, and the possibilities of successful treatment of malocclusion depend largely upon the response to growth stimulation by a healthy organism.

Before examining the dental arches themselves for possible local causes of a malocclusion, the nose and the throat should be examined for possible obstruction to nasal breathing, as the existence of narrow nasal passages, hypertrophied turbinates, deflected septi, etc., in the nose, or adenoids and enlarged tonsils in the throat should be recorded with the idea of rhinological reference for their treatment.

Abnormal habits such as sucking the thumb, fingers, lips or cheeks, or biting the nails, should be recorded with the idea of preventive treatment.

Abnormal respiratory function should be observed, and the fullness or flatness of the chest, its dimensions and increase in size on respiration noted. The local effects of mouth breathing in its unbalancing of the facial muscles, and its effect upon the malocclusion and the child generally should be determined.

Mouth-breathing, especially, will be readily detected from an observance of the distortion of the face and mouth peculiar to this pathological condition. The presence of enlarged tonsils may be easily seen with the tongue depressed slightly, and adenoids may be felt with the index finger carefully and quickly inserted into the throat above the uvulæ. The examination for adenoids and deflected septa and other nasal obstructions should be made by the rhinologist as soon as there is any suspicious indication of there being such pathological conditions present in the case.

Thus, a thorough diagnosis of any case of malocclusion should include the observance of every pathological indication in the oral cavity and adjacent parts of the head and face, as well as in the body as a whole, for only with a full understanding of all of the variations from normal conditions locally and constitutionally is it possible to discover the relation between the etiological factors concerned and the malocclusion, and form an accurate judgment in the prognosis of a given case.

Moreover, as any diagnostic interpretation is of value only in so far as it is of use in prognosis, it will be recognized that the greatest benefits to be secured from treatment can only be assured by an intelligent perception of all the etiological and pathological factors involved in the case, no one of which is so obscure as not to be considered.

Hence, the history of the patient, with carefully outlined subjective and objective symptoms of pathological significance, should be a matter of careful detail and should be recorded systematically for future reference in the treatment of the case.

Having recorded all diagnostic features of a constitutional and general nature, and of a regionally associated nature, the malocclusion itself should be distinguished from other forms, the malposition of individual teeth and the anomalies of dentition noted, the size, shape, and relation of the dental arches, and the arrest or over development of the maxillary and mandibular arches determined; and, finally, the effect of the malocclusion upon the facial lines defined.

The malocclusion, therefore, should first of all be classified, and the absence or loss of deciduous or permanent teeth, or their partial loss through caries, and the respective stages of eruption of the permanent teeth observed.

If the deciduous teeth are present in part or whole, it should be noted whether they occupy their full mesio-distal space, and are assisting by their presence in the development of the arches. Their premature loss is usually indicated by a closing up of part or all of the space which they originally occupied, and indicates non-development.

A primary examination of the permanent denture should first deal directly with each individual arch, noting the absence of teeth, and their effect upon each arch, tracing minutely the changes incident to their removal in the contraction of the arch, and secondarily the effect upon the occlusion and articulation.

Accurate plaster models should be made, and the variation from symmetry and from the normal sizes of the dental arches determined by some method of measurement, and the amount of development needed should be ascertained by some simple method of arch pre-determination if possible.

Unerupted and impacted teeth should be located and the possibility of their being erupted into the normal arch alignment determined. These latter conditions as well as the health or disease of erupted teeth, the presence of tumors, abscesses, cysts, etc., the stage of eruption of unerupted teeth, as well as many other conditions within the osseous structures of the jaws can be best found out by means of the X-ray.

CHAPTER XXXIX

DIAGNOSIS—CONT'D.

RADIOGRAPHIC DIAGNOSIS

Value of the X-ray in Orthodontia.—The use of the Roentgen or X-ray has been of inestimable value to the orthodontist in enabling him to determine the congenital absence of teeth, the non-absorption and premature absorption of the roots of the deciduous teeth, the location and position of unerupted and impacted teeth, pressure absorption of the roots of teeth, the presence of supernumeraries, the effect of movement of deciduous and permanent teeth and to note various abnormal or pathological conditions of the roots of the teeth or their investing tissues.

This is properly considered under diagnosis, for with such fore-knowledge of the anatomical defects, if any, that the radiograph shows, the operator is able to progress with any otherwise doubtful case without

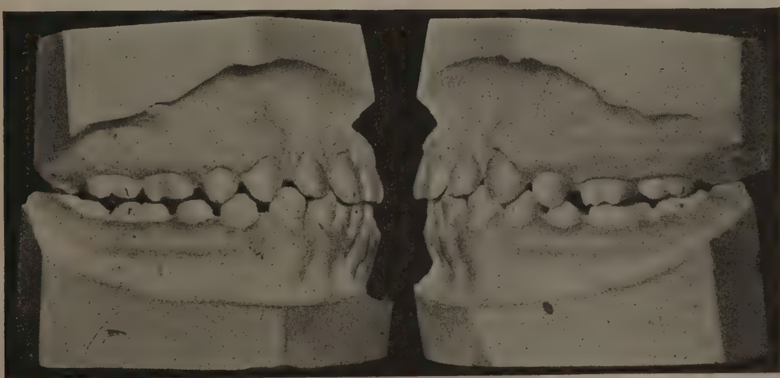


Fig. 608.—Absence of upper second bicuspid germs in case of prolonged retention of deciduous second molars.

delay, or the possibility of a mistake in treatment due to lack of previous knowledge of the exact conditions present.

X-rays should be taken of every case of malocclusion both extra and intra-orally as a part of the diagnostic record of the case, since in no other way can abnormal conditions of development of the teeth and their surrounding tissues be made apparent before the beginning of treatment.

An excellent procedure is to take extra-oral Roentgenograms of both sides of the face in every case, and to check up on any particular region of

the extra-oral films in which the development of the teeth is seen to be faulty by the intra-oral films.

Congenital Absence of Teeth as Shown by the X-ray.—Not infrequently is the orthodontist called upon to diagnose the presence or absence of a permanent successor to a deciduous tooth, which the radiograph alone will determine. Such a case is seen in Fig. 608.

Fig. 609.—X-ray of Fig. 608—right side.

Fig. 610.—X-ray of Fig. 608—left side.

The long retention of the deciduous molars on both lateral halves of the arch caused some anxiety on the part of the family dentist in charge of the case, as he thought they ought to be extracted to show the permanent successors to erupt.

Fig. 611.—Upper cast exhibiting impacted right cuspid.

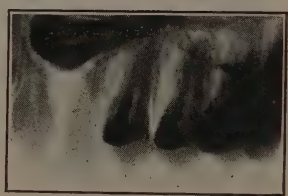


Fig. 612.—Radiograph locating position of impacted cuspid in case shown in Fig. 611.

An X-ray was secured of both lateral halves and the radiographs, Figs. 609 and 610, showed that the second bicuspids were not present, having failed to develop, and the deciduous molars, retaining their full length of roots bid fair to act as efficient substitutes for the absent bicuspids for many years.

Determining the Position of Unerupted Teeth by the X-ray.—Frequently the cuspid will assume such a position in the alveolar process that its proper eruption would require surgical interference, as in Fig. 612.

Fig. 611 represents the cast of an upper arch in which the cuspid is missing on the right side, and the space for its eruption entirely closed up. The radiograph of this case, Fig. 612, exhibits the cuspid in an unerupted stage slightly lingual to its position, and the indications for its eruption into position by opening up the space for it between the lateral and first bicuspid are more favorable than if it were lying transversely in the dental arch.

Locating Unerupted Supernumerary Teeth.—The presence of supernumerary teeth, if unerupted in the dental arch, can not be discovered except by means of a radiograph. An unerupted supernumerary tooth will deflect a normal tooth from the arch line to a considerable extent or rotate it as shown in Fig. 613. The radiograph, Fig. 614, exhibits a small

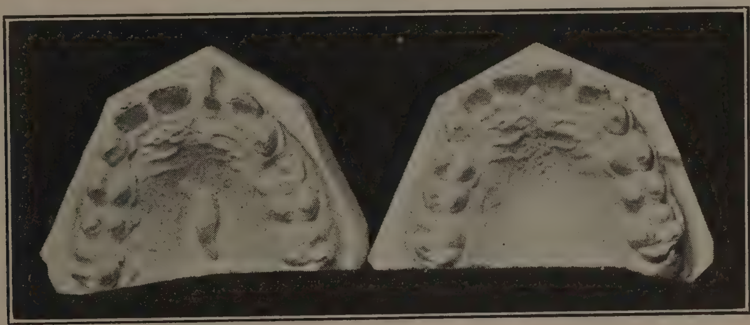


FIG. 613.—(Left) Torsion of central incisor due to supernumerary. (Right) Rotation of central incisor after extraction of supernumerary.

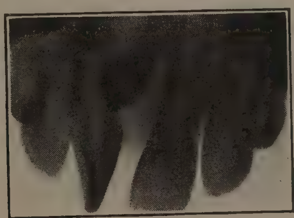


FIG. 614.—Radiograph exhibiting supernumerary tooth deflecting upper central incisor in Fig. 613.

supernumerary tooth immediately lingual to the right central incisor, and only after the surgical removal of the supernumerary tooth could the right central be rotated.

X-ray Machines.—The equipment necessary for radiographic work by the orthodontist need not be complicated, cumbrous, nor costly, and there

are a number of efficient machines of simple design on the market which will admirably fulfill his purposes in radiographic diagnosis. One of these simple and compact machines, designed by Dr. L. M. Waugh, is shown in Fig. 615.

Fig. 615.—The Waugh radiographic unit.

An X-ray outfit and laboratory, for the sake of its convenience, in enabling the orthodontist to immediately secure films of the mouth in doubtful cases and thus avoid delay in diagnosis, as well as to use it in every case for the value of the knowledge of the conditions otherwise unknown of the developing dental and osseous structures, has become almost an essential part of the orthodontist's equipment.

CHAPTER XL

DIAGNOSIS—CONT'D.

DETERMINATION OF ARCH ASYMMETRY

Inequalities of Growth of the Dental Arch.—One of the essentials of diagnosis of a malocclusion other than its classification, its individual tooth malpositions, and radiographic findings is the determination of the inequalities of growth of the dental arches as shown by a careful study of the casts of the teeth from the occlusal and other aspects.

The dental arches of every case should be examined from the plaster casts with a view to discovering asymetrical and abnormal development which should be corrected. Frequently one lateral half of a dental arch is developed more than the other half, or the molars and bicuspids on one side may have drifted forward beyond the molars and bicuspids on the opposite side of the arch.

Again, the curve of the occlusal plane of one arch may be abnormal, requiring special treatment for its correction, and not infrequently infra version of either the anterior or posterior portions of the dental arches may be noted in the study of the case from the frontal, lateral, and occlusal views.

Every dental malocclusion exhibits a certain degree of asymmetry in length, breadth or height and a careful survey of all of the deviations from the normal will reveal many defects not noted in a casual examination.

In many cases, especially in those which the teeth have drifted mesially or distally, lingually or labially from their normal arch positions, it is impossible to correctly classify them until these deviations have been noted from an accurate study of the occlusal aspect of each dental arch.

In cases where teeth are missing on one or both lateral halves of the dental arches, and the remaining teeth have moved out of the normal arch positions, it is important to determine the direction and extent of deviation of these teeth before classification is decided definitely.

An accurate method of determining the symmetry or asymmetry of one lateral half of the dental arch as compared with the other, and of the relative positions of the teeth in each lateral half, measured laterally from the median line of each dental arch and mesially and distally from any selected tooth, has been devised by Dr. Grunberg in the use of an instrument called the symmetroscope, shown in Fig. 616.

Grunberg's Symmetroscope.*—This instrument consists of a base A with four grooved posts which permit of raising or lowering and fixing the metal plate B to the height of the cast to be measured, which is placed under the triangular opening C.

The median line of the plaster cast measured from between the central incisors is placed in registration with the center or ninety-degree line of the symmetroscope, and the plate lowered so that the strings come in contact with the teeth. The side strings E and F are then brought nearly into approximation with the buccal surfaces of the bicuspids and molars, pre-

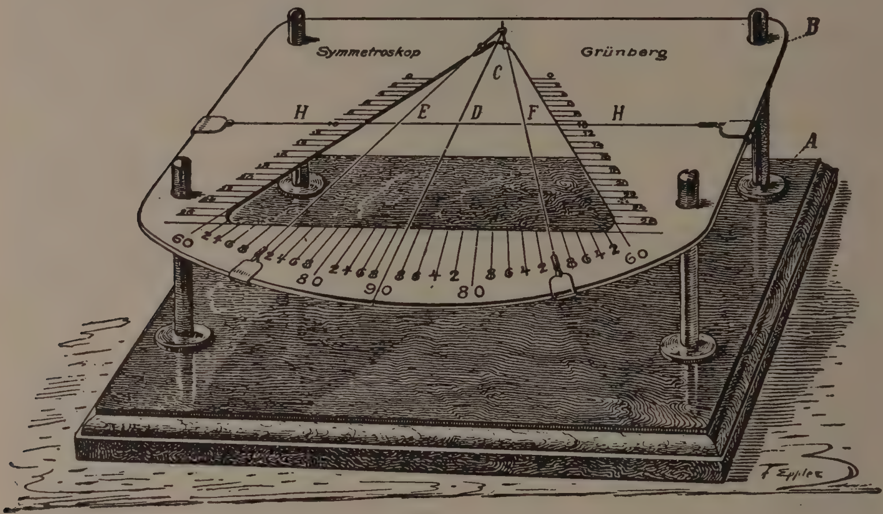


FIG. 616.—Grunberg's symmetroscope.

serving equal angles with the ninety-degree line on each side, however, and by observing whether or not these strings intersect homologous points of homologous teeth, any variation from bilateral symmetry is immediately shown, the angles between these lines being measured in degrees on the face of the symmetroscope. This instrument is also valuable in determining the relative mesial or distal positions of the bicuspids or molars. The horizontal string H is moved backward and forward in a parallel plane at right angles to the ninety-degree line to determine variations from the normal mesial or distal relationship of the bicuspids or molars. If the three lines E, F, and H intersect homologous points in all portions of the cast, the arch is symmetrical. Any variation buccally, lingually, mesially, or distally is made at once apparent by noting the deviation from the lines of the guide strings. Fig. 617 shows a cast in position in the

* Dr. Joseph Grunberg, The Symmetroscope, *Dental Cosmos*, April, 1912, Page 490. Review from Oesterreichisch—Ungarisch Vierteljahrsschrift fuer Zahnheilkunde, Vienna, No. 2, 1911.

symmetroscope for noting these variations in symmetry of the dental arch. The extent of the migration of molars in mutilated cases may thus be quite accurately determined with this instrument.

A modification of this instrument by Dr. Friel* consists in a rearrangement of the guide strings on each side of the 90° line so that they are free to move at both the upper and lower ends along a graduated horizontal scale, thus being capable of a movement in parallel planes instead of

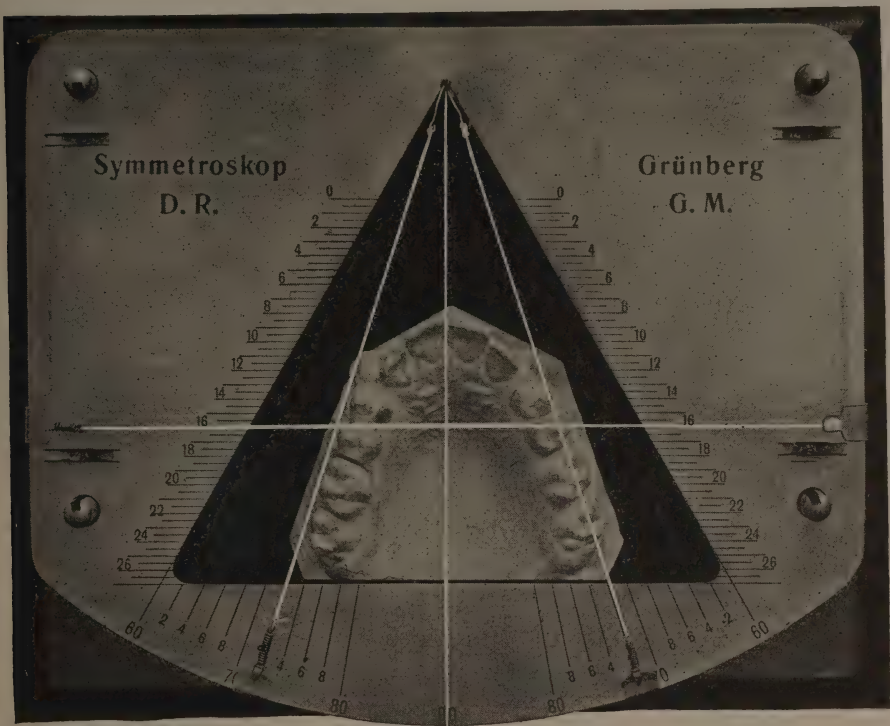


FIG. 617.—Upper cast in position in Grunberg symmetroscope for determination of asymmetry of the dental arch.

rotation only around a central axis as in Grünberg's original plan. Friel's modification of Grünberg's symmetroscope simply gives a greater scope of usefulness to the original instrument in that it affords better facilities for correctly placing in registration the casts of badly mutilated cases, of cases of unilateral lingual occlusion, in cases of which the centre of each arch between the central incisors has drifted to one side, and of combinations of these two or three conditions occurring in malocclusion.

A method of obtaining the correct relation between the plane of occlusion and the facial lines in the plaster model and face mask, as shown in

* Dr. Sheldon Friel, Diagnosis of Malocclusion of the Teeth, *Dental Cosmos*, July, 1914. Fig. 7. p. 827.

Fig. 618, is described by Dr. Van Loon. The advantages of this method of thus correctly relating the teeth in the model to the facial profile by certain accurate measurements from facial landmarks, and the establish-

FIG. 618.—Relating the occlusal plane and the teeth in the model to the facial lines. (*After Van Loon.*)

ment of a special technique for the trimming of models, are that the model, when placed within the face mask, "reproduces the deviations in all directions precisely as they appear in the patient." The reader is referred to the monographs describing the method in detail.*

* Dr. J. A. W. VanLoon, A New Method for Indicating Normal and Abnormal Relations of the Teeth to the Facial Lines, *Dental Cosmos*, Sept. and Oct., 1915.

CHAPTER XLI

DIAGNOSIS (CONT'D)

PREDETERMINATION OF THE DENTAL ARCH

Arch Predetermination.—It is almost impossible to foretell without some definite plan the exact size and shape that the dental arches should present after treatment, nor is it always a necessary part of diagnosis, especially in the simpler cases which develop into the proper sized arches according to the type of individual without any particular planning or plotting out of the estimated size and shape of the arches before treatment.

However, in the more complex cases, in view of the difficulty in judging the exact width and length a dental arch should be developed, it is becoming more and more customary to have some pre-determined plan of the dental arch, however simple.

An accurate conception of the normal size and shape of the dental arches in malocclusion is not a matter of guesswork since the mechanically and anatomically reconstructed arch has been made a possibility by the application of the laws of Bonwill in the reproduction of the normal arch for any given case, as worked out geometrically by Dr. Hawley, who by a reversal of the method of triangle construction of Dr. Bonwill has succeeded in predetermining the size of the arch by constructing a triangle from a primary measurement of the arc of the centrals, laterals and cuspids.

A scientific determination of the normal arch in any case of malocclusion not only removes any doubt as to the extent of arch development in treatment, but provides for the establishment of the normal function of articulation, which is most important in mastication, and the preservation of arch integrity, which the construction from an equilateral triangle aided by the proper depth of overbite, and the proper compensating curves from cuspid to molars, affords by the harmonious working of these laws.

Quoting from Dr. Hawley's article on arch determination, the construction of the triangles and reproduction of the normal arch for any given case is as follows:

Bonwill's Diagram.—"In Fig. 619 we have Bonwill's geometrical figure, an equilateral triangle, AFG, inscribed within a circle, its base FG representing the distance between the condyles, which varies in the living subject from three to five inches. According to his plan, in artificial dentures, the teeth are arranged with the cuspids and incisors in the arc

of the circle AJCH, the size of which varies according to the teeth selected for the case, and this selection is left to the judgment of the operator."

Dr. Hawley's Diagram.—"In order to use this principle in orthodontia, where we have the size of the teeth given us, and from their widths the diameter of the circle AJCH, we must reverse the order of procedure and find a connecting relation between this circle and the equilateral triangle AFG, or the circle within which it is inscribed. This connection is not described in Bonwill's writings so far as I have been able to find. It is

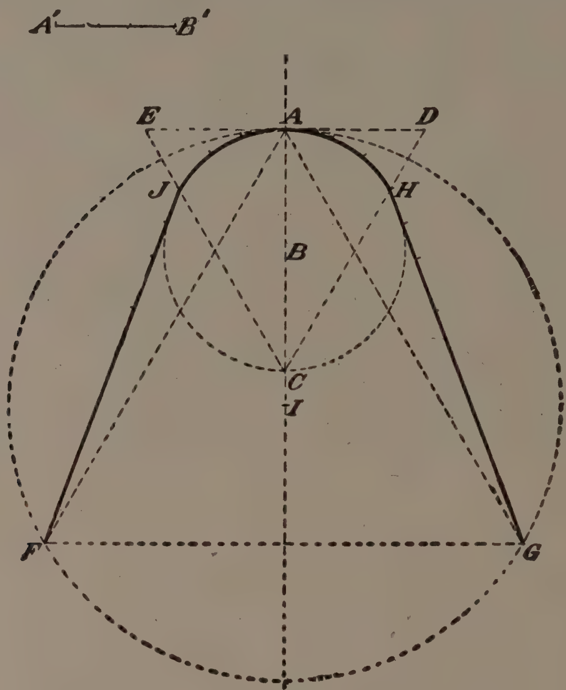


FIG. 619.—Bonwill's triangle of the dental arch.

found in the triangle EDC, constructed with its apex at the point C, on the diameter of the circle AJCH, and its base tangent to the same circle at A, the sides passing through the points J and H, located on the circle by the distance of the radius from A."

"In application, to construct the diagram, we take the radius of the circle AJCH from the combined widths of the central, lateral, and cuspid teeth shown at A′B′. With this radius AB, upon the line AC, which becomes the extended diameter of the circle, draw the circle AJCH, and with the point of the compass at A, mark off the radius upon the circumference at H and J. We have here the arc of the circle upon which the six front teeth are to be arranged, but know nothing of the size of the triangle AFG."

"From C draw the lines CE and CD, through H and J, extending them indefinitely and draw a tangent to the circle A, cutting these lines at E and D, and forming an equilateral triangle ECD. Take one side of this triangle as a radius, and with one point of the compass at A, and the other upon the extension of the diameter at I, describe the large triangle AFG. Then draw the lines FJ and GH, and we have the desired diagram or arch upon which we may measure off the teeth with the width as found in the mouth."

The Simplified Method.—Although this gives a very graphic idea of the normal arch for a given case, Dr. Hawley's second method is more practical because of its not requiring special artistic ability in drawing, and but a short time is needed to complete it.

FIG. 620.—Dr. Hawley's celluloid diagram of the dental arch predetermined from width of central incisor superimposed over upper cast.

The line drawing of the predetermined arch is transferred to a piece of transparent celluloid, and by placing this in position over the occlusal surfaces of the teeth of an upper or lower cast of the case before treatment, the extent of tooth movement and change in the shape of the arch laterally and anteriorly, is very plainly indicated.

Fig. 620 represents the upper cast of a case of malocclusion of Class II, Div. 1, in which it was desired to determine the normal size and shape the arches of teeth should assume after treatment. The superimposed diagram is seen upon the upper cast of the case before treatment, and indicates considerable widening and shortening of the arch. Fig. 621 shows the same case after treatment, the teeth having been brought to the required arch. In this case the combined widths of the central, lateral, and cuspid were taken to determine the selection of the proper arch. In

the lower arch of this case, not so much widening was required owing to the fact that it has assumed a distal position.

Comparative arch and tooth measurements in the mouth and on the diagram in the progress of a case, will serve as a constant guide to the attainment of the predetermined arch. These measurements are made with a scale graduated in hundredths of an inch, and one with specially fine points has been adapted by Dr. Hawley for the purpose, as shown in Fig. 619.

Table of Average Measurements.—So far, in the use of this method, the measurements have been taken from arches in which the full comple-

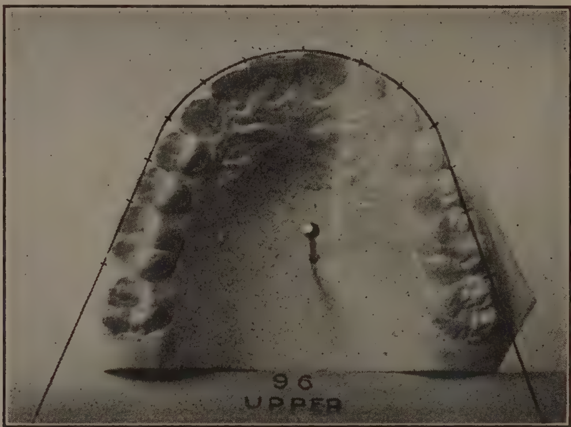


Fig. 621.—Same case as in Fig. 620 after treatment and restoration of arch size to that of the diagram.

ment of permanent teeth is present, but, by means of a system of comparative tooth measurements in a large number of cases in which the permanent teeth are all present, Dr. Hawley has succeeded in formulating a table of average measurements, especially of the centrals, laterals and cuspids, so that by the measurement of a single central incisor in a case in which the permanent centrals and first molars were the only teeth erupted of the permanent dentition, the width of the permanent lateral and cuspid to be erupted later may be quite accurately gauged, and consequently the arc of the anterior teeth from which the entire permanent arch is determined.

Quoting from Dr. Hawley, the method of making these tables and their applicability may be more clearly shown as follows: "Now, if the teeth were found in the mouth in the same proportion in respect to their greatest and least width, that is, if with a .31 central, we would find a .19 lateral, a .27 cuspid, a .27 first bicuspid, a .23 second bicuspid, and a .35 molar, and so on with each size of central, we could make out the radius

of each size central, and from these draw proportional diagrams. But such is not by any means the case, for, with a .31 central, we often, in fact usually, find a lateral .26 or .27, and the cuspid may be quite well up in the scale, or we may have a central and lateral in good proportion and the cuspids much larger."

"In order to discover the nature of this variation, I selected from the 100 measurements all the cases of each width of central, and made of each of them a table."

"The number of cases of each size central was .31, fifteen, .32, seven, .33, sixteen, .34, sixteen, .35, nine, .36, fourteen, .37, thirteen, .38, five, and .39, two.

Collecting each of these sets, nine tables were made, each representing the variation in width of the laterals, cuspids, bicuspids, and first molars in arches in which the central incisors were all of the same width, of which the table below of the .35 central is an example:

Central	Lateral	Cuspid	1st Bic.	2d Bic.	1st Molar
.35	.24	.31	.27	.27	.41
.35	.28	.31	.29	.30	.41
.35	.25	.30	.25	.25	.42
.35	.28	.31	.28	.27	.42
.35	.27	.33	.29	.29	.44
.35	.24	.30	.30	.28	.41
.35	.28	.33	.29	.26	.40
.35	.26	.30	.27	.27	.43
.35	.27	.32	.27	.27	.41
Average:					
.35	.27	.31	.28	.27	.42

The average measurements of the nine tables were then computed, forming an average table with centrals of varying width from .31 to .39, and the average width of the other teeth, as in the following table:

Central	Lateral	Cuspid	1st Bic.	2d Bic.	1st Molar	Radius	Corrected Radius
.31	.26	.29	.26	.26	.39	.86	.86
.32	.26	.30	.27	.26	.40	.88	.88
.33	.27	.30	.28	.27	.41	.89	.90
.34	.28	.30	.28	.28	.42	.92	.92
.35	.27	.31	.28	.27	.42	.93	.94
.36	.28	.32	.28	.28	.42	.96	.96
.37	.28	.32	.30	.29	.42	.97	.98
.38	.28	.34	.30	.29	.44	100	100
.39	.31	.34	.31	.29	.44	104	102

The combined widths of the central, lateral and cuspid in each one of the nine tables, represent the radius that may be used for the predetermination of the arch.

The Corrected Radius.—A corrected radius at the extreme right of the table is based upon a uniform variation of .02 of an inch from .86 to 102.

Quoting again from Dr. Hawley: "Now, taking these corrected radii, we will get an arch for each width of central, and I will propose these as a

basis of diagnosis, study and treatment of cases where only part of the teeth are erupted, or under the age of twelve."

"Or using the radius in hundredths of an inch for comparison, the diagrams may be used as guides for all cases, for where we can measure all the teeth, we have only to select the diagram with the correct radius, and measure in the teeth. Remembering that these arches are only averages, and smaller or larger teeth will constantly occur in connection with the particular central, is there any indication by which we can judge in which direction this variation will occur, *i.e.*, toward smaller or larger teeth? I think we have this in the first molar, and this tooth is always present at the time of eruption of the central incisor. As the first molar varies up

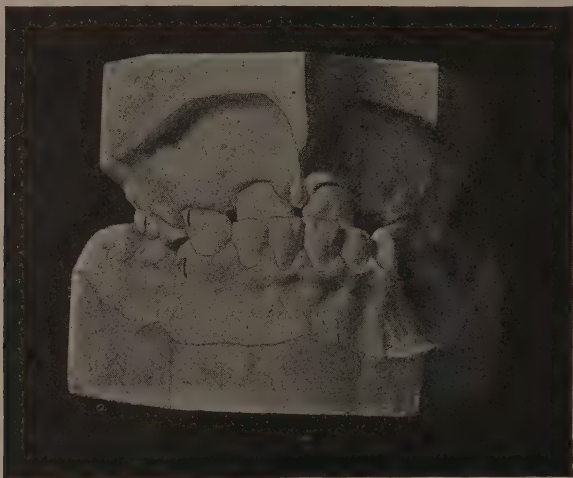


Fig. 622.—Mixed denture with .39 in. upper central incisors. (*After Hawley.*)

or down from the average width, I believe the rest of the teeth will vary. For instance, we will suppose we have a case in which the central incisor is .34 and the first molar is .42. If I had a second case with the same size central, but with the first molar .44, I would presume that the lateral and cuspid, and all the rest of the teeth would be likely to be large, and would select the next larger arch. In this way I think we have the key to a fairly accurate judgment of the future denture."

"In making up these averages, I have tried to err, if at all, on the side of the larger arch, believing if we do get the arch slightly larger than the teeth will fill, if it is properly shaped, and the teeth are placed in normal occlusion, as the excess will, at the worst, be only a few hundredths of an inch, the pressure of the cheeks and lips, the influence of the occlusal planes and the pressure forward of the second molar in eruption will close the spaces."

In illustration of this use of the arches, let us take the case of a child 8 years of age.

In Fig. 622 there are erupted of the permanent upper teeth only the central incisors and the first molars. The central incisors are .39 of an inch wide, and as the molars seem to be of corresponding size we select the arch marked central .39, or taking at an average width of the lateral and cuspid, radius 102.

FIG. 623.—Diagram of .39 in. central superimposed on upper arch of Fig. 622 to show development necessary. (*After Hawley.*)

Fig. 623 shows the development that will be necessary, and Fig. 623 A, the finished case with the teeth brought to the ideal arch.

"Similar tables were made for the lower teeth, and the result makes it evident that the uniformity of lower arches, drawn from the measurements of the lower incisors and cuspids, is not to be depended upon. While the lower bicuspids and molars are fairly uniform in their relation to the upper, within the same mouth, the incisors and cuspids are not. This lack of uniformity is probably compensated for in the inclination of the teeth and the overbite. . . . . I wish to advise that instead of drawing the lower arch from measurements of the lower teeth, . . . the radius for the lower be taken from .13 to .23 of an inch shorter than the upper, depending within this variation on the size of the teeth or the distance from the line of occlusion to the crest of the buccal cusps."

"Fears have been expressed that, in bringing into orthodontia a mathematically and geometrically calculated plan, we would restrict or eliminate the feature of artistic judgment, and that the method leaves no room for the exercise of judgment in changing the form of the arch to satisfy the requirements of the various types. These fears or objections have been due to misconception of the elasticy of the method in its

application. . . . In so far as hampering, in any way, the use of judgment in the art requirements of orthodontia, this method lays down the most valuable principles, and forms the most important basis upon which artistic results in orthodontia must be accomplished; and instead of restricting the variation of the arch to correspond to different types, it forms the only safe guide for procedure in such variation."

"By restoring normal occlusion, and a form of arch in harmony with the size of the teeth, that will admit the natural movement of the mandible,

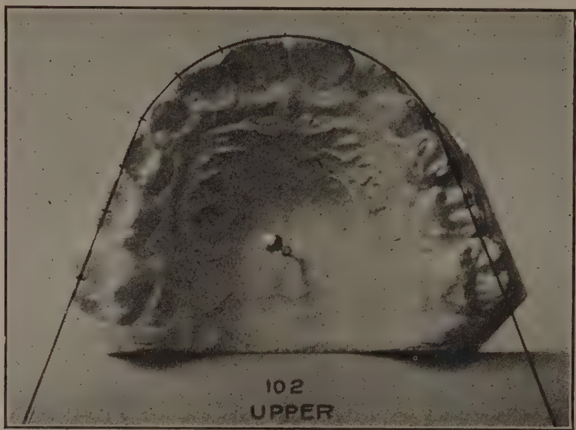


FIG. 623 A.—Diagram of .39 in. central superimposed on upper arch of Fig. 622 after treatment to show correctness of Dr. Hawley's method of arch determination. (*After Hawley.*)

we will thus, so far as the mechanism is concerned, obtain the natural development of the denture. And in retention, we will guard against any final retrogressive changes that might take place, by conforming the arch to the natural mechanical forces of articulation."

The pre-determined arch line, not only accurately locates the proper "line of occlusion," but enables one to more exactly designate malpositions of the teeth in relation to it.

It is true that the line of the pre-determined arch is not strictly conformative to type, but this is unessential, since the typal form of the arches is best produced through the attainment of the proper working of the mechanics of the laws of articulation from which the line of the pre-determined arch is derived.

Elaborate methods of predetermination of the dental arch by means of engineering surveys with special instruments have been devised by Dr. F. L. Stanton to a few of whose articles on the subject the reader is referred.*

* Orthodontic Engineering, by F. L. Stanton, D.D.S., Int. Journal of Orthodontia, Vol. II, 1916, pages 235–245.

Dental Surveying and Arch Predetermination, by F. L. Stanton, D.D.S., Oral Health, Vol. VI, 1916, pages 183–191.

CHAPTER XLII

ART CONSIDERATIONS IN ORTHODONTIA

Orthodontia the Realization of Art.—The study of art in its relation to esthetic configuration and beauty of the face is strictly in accord with the highest conceptions and ideals in orthodontia. An understanding of the lines of beauty and symmetry in the old masterpieces of sculpture, and painting, as for example, in the Venus do Milo in sculpture, Fig. 624, or the Madonna in painting, and others of similar beauty and perfection by more modern artists, enables the orthodontist to gain a broader conception of his own art. For orthodontia is the practice of an art based on a science, and it concerns itself with not only beauty of feature, but with the imprint

FIG. 624.—Venus de Milo—a photo of the original statue in the Louvre, Paris.

of character and personality upon the living human face of the individual rather than with the ideal conceptions of form, figure, and facial configuration, or the passing phase of expression in sculpture or portraiture as reproduced in ancient or modern art. Orthodontia is thus more vitally and intimately related to art in a practical way than is the work of the sculptor or painter.

Orthodontia, in a Sense, is Art Realized.—The pictures that the orthodontist paints are not on perishable canvas, the sculpture that he carves is not in lifeless marble, but his creative work is portrayed in moulding into lines of harmony and beauty the living tissues of the human face,

where, not one alone, but all of the expressions of which the human face is capable may be observed, and brought into lines of harmony and beauty according to his will, if within the range of possibility. The field of applied art in orthodontia embraces not only the physical, but also the mental attributes which are related to facial form and expression, and thus, through applied psychology, the scope of orthodontia as an art is almost limitless.

The lines of the face upon which the orthodontist applies his art are not necessarily limited to the dento-facial area, as has formerly been taught, but may be extended through the knowledge and skill of the operator to include all portions of the human face which are subject to the controlling influence of function, and the conscious control of facial expression. Primarily, however, the lower third of the face, and especially the mouth is concerned in the greatest transformations of the orthodontist's art.

The Mouth as an Index of Facial Expression.—"All artists and physiognomists agree that the mouth presents a greater variety of expression than any other feature. In portrait sculpture the mouth is the feature of all others for denoting expression. Neither the eyes, nose, forehead, ears, nor chin, nor all combined, have the power of conveying that of which the mouth is capable. It speaks even without utterance, of every emotion of the heart; love, anger, pride, scorn and contempt, equally with joy and sorrow, have their insignia stamped upon the mouth. These changes are so rapid, and their continuance so evanescent, that the phase, "catch the expression" is often used with but little idea of its full signification."* A physiognomist has said, "The soul dwells in the mouth, which is eloquent, even in silence."

Esthetic Considerations in Orthodontia.—To no one does the study of the human face, in its various types, forms and varied expressions, appeal with greater force, especially from the standpoint of esthetics, than to the orthodontist, who should be sufficiently trained in the principles of art as related to the face to quickly perceive and analyze perfection of form, and variety of expression. He should be able to note the characteristic points of resemblance or difference between individuals of various types as does the sculptor or painter in order to fulfill the demands and obligations of his art and practice it to the full measure of its ideal conception.

A broad knowledge of art, therefore, especially in the study of the finest masterpieces of painting and sculpture cannot but assist the orthodontist in realizing his highest ideals in the practice of a specialty whose greatest claim to usefulness, next to that of restoration of normal developmental conditions in the dental arches and internal face, and of improving the health, is the possibility of bringing harmony of facial lines and often

* Oral Deformities, page 529, by Dr. Norman W. Kingsley.

beauty out of deformity in the production of esthetic facial contour, and of determining the individual facial characteristics to no small degree.

Beauty Defined.—Beauty in relation to form and features has always been a difficult thing for even the artist to define, so largely does the personal equation enter into its appreciation, but the viewpoint of the artist in this respect is of great value to the orthodontist.

From the standpoint of esthetics, beauty of the face is always desirable, but a frequently lacking attribute. Beauty has been defined as "*the assemblage of graces or properties which are pleasing to the eye, the ear, the intellect, the esthetic faculty, or the moral sense.*"

No Absolute Standard of Beauty.—It has been pointed out by artists that there is no absolute standard for judging the beauty of the human face, although relative standards may be found in the average or composite such as may be seen in groups representing racial types, and in the variation in sex and temperament.

One prominent artist has said. "In attempting to study form in its relation to beauty in the human figure, the personal equation plays so prominent a part that we shall find the investigation beset with difficulties of an unusual nature. Form is apt to be so closely associated with other constituents of beauty, and the effect upon the observer to be so greatly modified by his own idosyncrasy, that we must be on our own guard against errors arising from such a source. Nevertheless, if we compare the male with the female figure, the Caucasion with the Mongolian or African race, Greek sculpture with contemporary life—if we recognize the innumerable differences both of type and of the individual among all races, *we shall find it hard to believe that any abstract standard of beauty can be formulated.*"*

This artist further remarks, "Artists and sculptors, consciously or unconsciously, have been guided by a harmony of relation of the features to the head, of the head to the figure, and of the figure to a group marked by physical similarities among its members. The latter can best be illustrated by a reference to Greek sculpture. One need only recall the representations of Apollo, Hercules, Diana, Venus and Minerva, to realize that comparatively simple types have been embodied in these statues."

Artistic Ideals in Greek Statuary.—The Greek sculptors always carved ideal heads and faces and they sought by an exaggeration to idealize the profile of the human face. By increasing the fullness of the forehead they gave to the heads of gods and heroes a facial angle of more than ninety degrees. Thus in the classic head of the Apollo Belvidere, Fig. 624 A, may be noted a facial angle of considerably more than ninety degrees.

The face of the Venus de Milo, Fig. 624, while not being as exaggerated in the fullness of the forehead as the Apollo, represents another ideal type

* Facial Expression from the Point of View of the Artist, by Henry Read. Proceedings of American Society of Orthdontists, 1910, page 145.

of Greek beauty, and although the statue is an unequaled masterpiece of sculpture, and the beautiful lines of the face are too classic and ideal to serve as a model for comparison with present day types of facial beauty, the symmetry and proportion found in this face has never been equaled in ancient or modern sculpture.

The Greek heads in general present a calm and dignified repose, no doubt expressive of the unruffled impassivety of the god like characters

Fig. 624 A.—Apollo Belvidere.

types of faces. It is thus evident that the profiles of the antique in sculpture are of very little value as a guide to the true proportions of the face, especially of modern races of mankind which bear very little resemblance to the ideal classical faces depicted in Grecian or other ancient sculpture.

Professor Wuerpel says, "The ideal of the Roman type, though markedly different from the Grecian, was also closely followed by their painters and sculptors, and where types and religious ideals were so distinctive, and so closely adhered to, there could be certain standards and laws to govern them, especially to creative art; *but to use the Grecian or Roman standard as a gage for the types of the present day would be impracticable*, for our inheritance, our occupations, our mental activities, our habits of thought, our social and climatic conditions, etc. differ so radically, and all these play such a vital part in the molding of the mental, moral and physical as expressed in our whole bodies and especially in our faces, that a standard type is an impossibility. *The tendency of modern civilization seems to be to create a law for each individual, and in the face of complex and*

constantly changing conditions a fixed typed as a basis or standard to govern the molding of the human face cannot be established."

Artistic Balance and Harmony of Facial Lines.—He further states that "no one is able to frame a set of rules covering the proportions of the human countenance which shall be a safe guide under all circumstances. The combinations of spacing in the given area of the human face are so amazingly great that there can be no possible enumeration of rules covering them. They each become an individual case, and we have to apply the principles of balance to each one in order to establish the ideal arrangement for the particular case." . . . "Harmony in art is that element which draws all parts together so that one shall not obtrude in preference to another." . . . "Harmony as applied to the human face is perhaps just as subtle in establishment as is the establishment of balance."

FIG. 625.—Well balanced profile—American type.

"*The highest beauty is consistent harmony and balance*, and without these qualities neither the modern type of American womanhood, the Greek types of the Venus de Milo, the Egyptian type of Abou Simbel or the impassive head of Buddha can lay any claim to our admiration." "Thus it would seem that a knowledge of balance and an instinctive desire for harmony are the only instruments which are placed at our disposal for the creation of any object of beauty—whether that object be a great temple, an entrancing picture, a delicate vase, a massive table, or an intangible human countenance."*

Hence, it must be obvious that no fixed "line of harmony" can exist in relation to the profile, and that beauty in any given face lies in the proper harmony and balance according to type. Dr. Farrar noted these

* The Principles of Balance and Harmony in Art, by Edmund H. Wuerpel. *The American Orthodontist*, Vol. ii, No. 4, pages 117–187.

principles in his studies of the esthetic relations of the face in orthodontia. He remarks in speaking of "an approximately well balanced face," that "all features harmonize and each one balances with each and all."*

The harmony and balance of the profile of an American type shown in Fig. 625 illustrate these principles in relation to facial beauty, the features all harmonizing in delicacy and refinement, in the correspondence of graceful curves, in symmetry and proportion, and each part of the profile being in balance and harmony with every other part.

The profile may be said to exhibit the standard of symmetry and proportion of the face which governs all other features. "The profile well chosen, all the other features will be made to harmonize with it, and according to the profile will correspond in form the beauty of all the other features. *No face was ever repulsive where the profile was beautiful, and no face can be made beautiful where the profile is ugly.*"†

Dr. Crosby ‡ has said "each student of art is taught certain proportions and measurements, which, though by no means arbitrary, form a conscious or unconscious scale of proportion. The infinite variations from this ideal make faces, which, though no two are exactly alike, still have much in common."

"An artist with his trained eye is quick to see faults which the layman fails to detect even when distinctly conscious of some jarring note."

"The value of line in painting and sculpture, architecture and even craftsmanship, is universally appreciated, but only art students know the strenuous drill needed to secure it."

Hence it is that the orthodontist should develop a sense of the symmetry and proportion of the face by means of such methods of measurement as are existent among artists and sculptors in order that he may attain their quickness of perception in noting inharmony in the facial lines.

Landmarks of Facial Symmetry.—A well balanced profile, in spite of the variations in type, should exhibit certain proportions of one part to another, and certain definite measurements have been made by artists from the earliest times to illustrate facial symmetry and proportion. Artists have adopted certain lines of division of the profile for the purpose of securing symmetry and proportion, which, while they cannot be applied advantageously to every face, afford the only definite means of determining the symmetrical proportions of the facial lines of the average face.

As noted in Fig. 626§, the profile is divided into four equal parts from the top of the head to the bottom of the chin, and include respectively the portion of the head from the crown to the hair line, the height of the forehead, the length of the nose, and the mouth and chin. The last

* Esthetics in Dentistry, by Dr. J. N. Farrar, *Dental Cosmos*, Dec., 1896, page 1001.
† Oral Deformities, page 475, Dr. Norman W. Kingsley.
‡ The Highest Aim of Science, *The American Orthodontist*, October 1907, Dr. A. W. Crosby.
§ From the Art of Figure Drawing, by Wiegall.

quarter is bisected, the upper portion including the lips, the lower portion, the chin.]

Three points of the face, also, are in the circumference of a circle described by the compass with the condyle as a center. These points are the point of the chin, the tip of the nose, and the frontal eminence, and an equilateral triangle including these three points may be inscribed.

Other measurements for determining the position of the eyes and ear, and the relationship of the mouth and lips, etc., may be of occasional benefit to the orthodontist in measuring the actual profile.

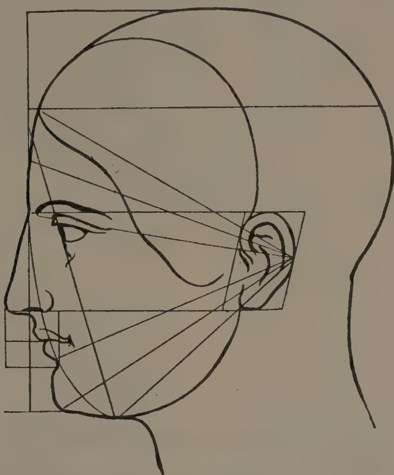


FIG. 626.—Divisions of a symmetrical profile into four equal parts. (*After Wiegall.*)

Facial Symmetry from the Orthodontist's Standpoint.—Beauty in the facial lines, as expressed by symmetry and proportion of external contour, suggests to the mind of the orthodontist an approach to perfection of form and structure of the tissues underlying the plastic tissues of the face, viz., the osseous structures and sinuses of the internal face, and the full normal development of the dental arches. However, typical anatomy in these regions is not symmetrical, although it approaches symmetry in many cases. Facial symmetry in cases which approach the ideal consists of the normal and proportionate development of facial contour and is dependent upon a corresponding development of the underlying osseous structures and sinuses. With this understanding of facial symmetry, one may look for a proportionately developed face, exhibiting harmony and balance, only in those cases in which the dental arches as well as all of the other structures of the internal face are normally and proportionately developed, and with the teeth in normal occlusion.

Dr. Angle has concisely stated this in the following words: "*the best balance, the best harmony, the best proportions of the mouth in its relations*

to the other features require that there shall be the full complement of teeth, and that each tooth shall be made to occupy its normal position—normal occlusion."

The full normal development of the dental arches is just as essential to the harmony and balance of the facial lines immediately external to the teeth, as the normal development of any other part of the internal

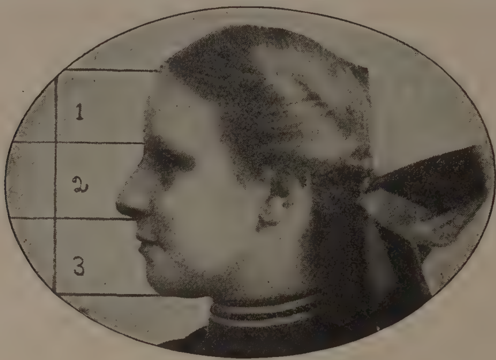


FIG. 627.—A balanced profile.

face is necessary to the rounding out in perfectly balanced contour of any other part of the external features. Hence, the diminution in size of the dental arches or their malrelations in malocclusion disturbs the balance of the facial lines to just the degree of malocclusion existing.

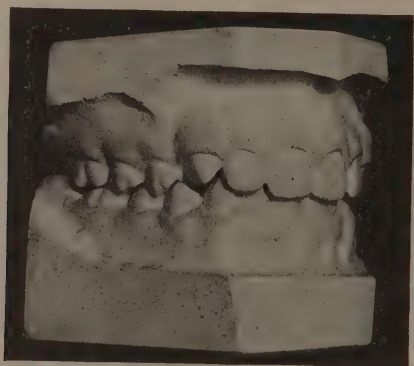


FIG. 628.—Occluded casts of teeth of child shown in Fig. 627.

These are the essential facts which most concern the orthodontist, who should not seek to compare the features of patients with classic ideals in art, but rather to observe the features directly concerned in his work, the lower third of the face including the mouth, lips, the chin and the cheeks which are out of balance and harmony with the rest of the features, forehead, nose, etc., and to determine the necessary treatment for the restoration of their normal balance in the individual case.

For the full development of the lower portion of the face, there must not only be perfect function in the respiratory mechanism, resulting in normal nasal breathing and development of the whole middle third of the face, but there must also be proper functional activity in mastication, and the absence of any untoward influence in dental arch development or unbalanced muscular activity. A well balanced profile exhibiting symmetrical and proportionate development of facial contour in the various portions of the external features, and corresponding curves in the pleasing facial lines, is shown in Fig. 627. In Fig. 628 the casts of the teeth of the young girl whose profile is shown in Fig. 627 exhibit a conformation to the normal in occlusal relations and development of the dental arches such as might be expected in a profile so well balanced.

FIG. 629.—Face mask of symmetrical profile.

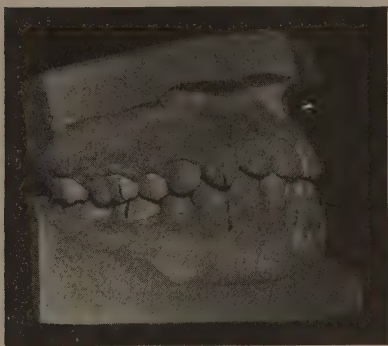


FIG. 630.—Casts of teeth of profile shown in Fig. 629.

Another well-proportioned profile with a correspondence of curves of the forehead, nose, lips and chin, is illustrated in Fig. 629. According to the principles of facial symmetry, it would be expected that the functions of respiration and mastication were unimpaired in this individual in order to have produced the correlation of symmetrical parts of the profile as seen in the illustration. The middle third of the face is well developed, the nostril wide and dilated, and there is no indication of any nasal obstruction which might induce a diminution of the normal breathing function.

The proportions of the lower third of the face are also so perfect that the diagnosis of almost perfect development of the arches of teeth and the absence of any marked malocclusion might be made with a degree of certainty, and upon examination of the model of the mouth in Fig. 630, the correctness of this diagnosis may be seen, there being but very slight deviation from the normal relationship of occlusion.

The art relations of the face are so intimately connected with the work of the orthodontist that a consideration of the development of the dental arches, the correction of malocclusion, or the training of the facial muscles, without studying the effect upon the artistic relations of the facial lines, would be inconsistent with the modern conception of art in its relation to the esthetic possibilities in orthodontia.

Facial Inharmony and Asymmetry.—Whereas in the perfectly balanced face the full complement of teeth in normal occlusal relations is essential for proper symmetry and proportion in any given type, in many faces which are out of balance it will be found that malocclusion and malrelation of the dental arches are the cause of the disharmony in the facial lines.

It is to this class of facial disharmonies or deformities that the artistic possibilities of orthodontia are naturally directed, and when one considers that malocclusion and consequent facial inharmony are so frequent, and that the mouth is the most expressive feature of the face, the artistic and esthetic facial transformations by orthodontic treatment offer the only hope for the perfection of facial balance, harmony, and often beauty, for thousands of children who would otherwise go through life needlessly deformed, or at least deprived of that full measure of harmony and balance of the facial lines which is their right.

It is obvious that with abnormal or arrested development of the structures of the internal face, the nasal sinuses, or the dental arches, with weakened or abnormal muscles of mastication and expression, beauty of the facial contour is an impossibility. No other portion of the face is so frequently maldeveloped as the lower third, which can exhibit by malocclusion and consequent deformity a greater disharmony in the facial lines than any defect or deformity in other portions of the face.

Area of Dento-facial Inharmony.—The area of dento-facial inharmony which is concerned in the artistic restorations of facial contour in orthodontia is chiefly included in the parallelogram inserted upon the lower third of the face as shown in Fig. 631, extending a slight distance above the lower border of the nasal cartilage **a** to the bottom of the chin **r** in the vertical plane.

In the simpler cases of malocclusion associated with a slight facial imperfection, the area of facial inharmony is included between the lines **ae** and **oc**, or the region of the lips alone, as in cases of slight arrest or deficiency in development of the anterior portion of the dental arches, or in the malocclusion caused by the loss of one or more of the permanent teeth. In some of the more complex cases of malocclusion such as mesioversion or distoversion, complicated by supra- and infra-version, abnormal respiratory function, and abnormal muscular action, the area of

dento-facial inharmony may extend throughout the whole zone of the parallelogram **aren** which is included by the jaws. In fact, the area may extend to include the end of the nose and the naso-labial depressions.

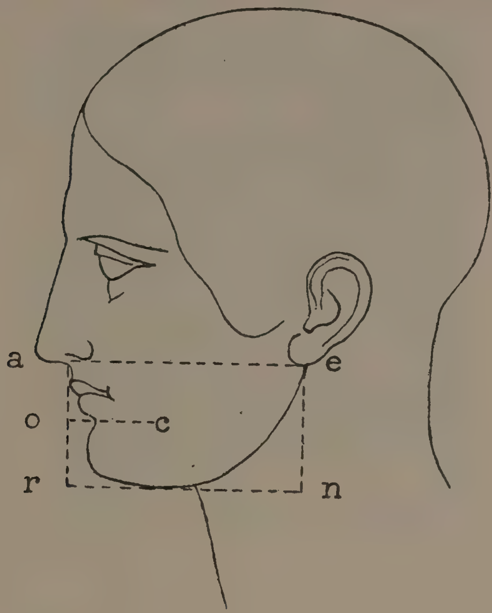


FIG. 631.—Area of dento-facial inharmony.

However, when one considers the wonderful changes in contour of the face which seem to include all of the various portions of the face after the restoration of normal occlusal relations and the strengthening and training of the muscles of mastication and expression, the field of dento-facial inharmony cannot be limited by geometrical lines or plotted zones.

FIG. 632.—Facial inharmony due to malocclusion.

Dento-facial Inharmony Due to Malocclusion.—Facial inharmony, as exhibited in the lack of harmony and balance in the facial contour in the lower third of the face, is primarily due to malocclusion or abnormal relations of the dental arches of varying degrees from the slight malposition of a single incisor tooth to the most extreme distal or mesial malrelationship of the dental arches with their various complications.

Examples of Dento-facial Inharmony.—The distance from the nose to the symphysis of the chin in some cases is often less than normal and infrequently greater than normal. For example, in the profile shown in Fig. 632 this distance is less than it should be normally because of the

infra-version of the molars and bicuspids, as is frequently the case in this type of dento-facial deformity.

The face is entirely out of proportion, exhibiting a protrusion of the mandible, and an expression which is entirely foreign to the character of

Fig. 633.—Malocclusion of case shown in Fig. 632.

the individual. The casts of the teeth, shown in Fig. 633, exhibit infra-version of the bicuspids and molars due to extraction, and a malrelationship of the dental arches sufficient to cause the extreme facial disfigurement.

Fig. 634.

Fig. 635.

Another case of extreme facial deformity shown in Figs. 634 and 635 owes its disfigurement to malrelations of the dental arches.

By drawing a line through the center of the face from the forehead to the chin, as in Fig. 634, a marked deviation from this line is noticed in the lower third of the face, caused by the malocclusion of the teeth, which forced the mandible to one side.

An examination of the profile of this case, Fig. 635, exhibits the further extent of the deformity, the chin being considerably protruded, giving the individual a senile appearance. The casts of the mouth of this young lady shown in Fig. 636 exhibits just such a lack of harmony in occlusion as one would expect from a study of the facial inharmony.

The functions of speech and mastication are seriously impaired, and were it not for the skill of the orthodontist, there would be no alleviation

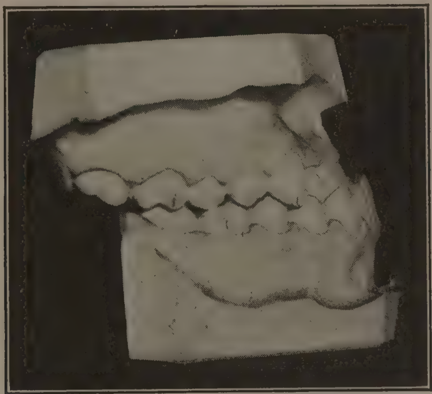


FIG. 636.—Malocclusion of case shown in Figs. 634 and 635.

of the deformed condition which is such a handicap to the one having such a facial disfigurement. The treatment of this case and restoration of the occlusion and correction of the facial deformity is illustrated in Figs. 938 and 939.

In the consideration of facial asymmetry, as related to dental arch development in orthodontia it is necessary to exclude the facial defects caused by such nervous lesions as paralysis, or the structural lesions of

FIG. 637.—Extreme maldevelopment of the mandible.

FIG. 638.—Facial deformity due to infraversion of anterior teeth (Fig. 639).

tumors, and other similar pathological manifestations not bearing directly upon the general laws of facial development, except such developmental neuroses as are admitted to be embryonic in character, and which, whether degenerative or not, must be taken into consideration by the diagnostician of structural deformities in any part of the body.

In some instances of dento-facial inharmony, the abnormal development of the mandible has been so great that orthodontic treatment is barely practicable, and operative surgery of doubtful benefit. A case of this nature is shown in Fig. 637, and, although beyond the age for ideal treatment, a very pleasing result in the restoration of esthetic facial contour was obtained through orthodontic treatment as illustrated in Figs. 946, 947, 948 and 949.

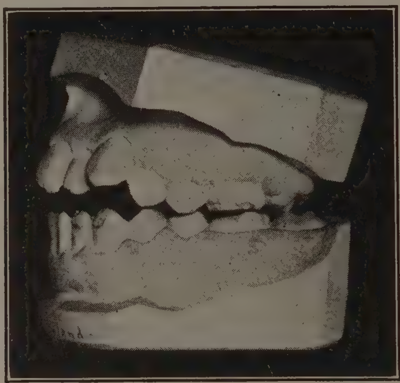


FIG. 639.—Malocclusion of case shown in Fig. 638.

The profile shown in Fig. 638 exhibits a serious facial deformity due to malocclusion, and one which, on account of pathological conditions of the internal face, and consequent maldevelopment of the mandible, will not readily respond to orthodontic treatment. Being an adult case, also,

FIG. 640.—Prominence of lower lip due to malocclusion shown in Fig. 641.

the disfiguring conditions have become confirmed through many years of mouthbreathing, infraversion of the anterior teeth, and malformation of the mandible. The malocclusion of the teeth is shown in Fig. 639.

A face may be perfect in its type except for some deformity in the lower third which may exhibit lack of harmonious development due to mislocclusion of the teeth.

For example, in Fig. 640, the profile conforms in most of its lines to its type, and contains many of the elements of beauty in some of its proportions, but the apparent prominence of the lower lip offsets all the esthetic characteristics of the other parts of the face and throws the features out of balance. A study of this profile will convince the trained observer that the apparent deformity or protrusion of the lower lip and of the mandible is an optical illusion, and that the upper lip alone is out of harmony with the rest of the profile, being retruded from the normal pose which it should occupy by reason of the lingual position of the upper incisors.

As proof of this diagnosis, a study of the occlusal relations of the arches of teeth in Fig. 641 exhibits a normal relationship in the molar region and an abnormal position of the upper anterior teeth alone, they being in linguoversion.

FIG. 641.—Linguoversion of upper anterior teeth in neutroclusion case causing prominence of lower lip in profile in Fig. 640.

Deformities of this nature, if allowed to go untreated, often affect the welfare and happiness of the unfortunate possessors for a whole lifetime, so keenly sensitive are they to public notice and unfavorable comment by those with whom they come into daily contact.

The habitual expression of the face of the individual having the appearance of the child shown in Fig. 640 is one of maturity rather then adolescence, and of unusul firmness and determination, and even of pugnacity, which is not truly indicative of its age nor of its character.

The possibilities of restoring the appearance of the real personality of the individual by esthetic restoration of facial contour in orthodontia thus extends beyond the realm of art as it is generally understood. In fact, although the developing of the personality is often included in orthodontic work through necessity, it is as often included through choice, because of the extreme fascination and interest in the production of permanent results which make for a larger share of usefulness and happiness for the patient.

This phase of the work is partly psychological in character due to the mental reactions caused by the restoration of pleasing facial lines from those of deformity, and to the realization that the social handicaps of one having a facial deformity which have caused the child to be shunned

FIG. 642.—Restoration of facial expression and personality after treatment of malocclusion.

or take a secondary place in its association with its playmates have been removed, and it can associate with others on an equal plane.

The protruding upper teeth and receding chin in certain malocclusions often suggest weakness, stupidity and sometimes subnormal mental qualities which are entirely foreign to the character of the child, although the child that is judged by others to be weak and timid, will through the mental reactions, finally come to consider itself in the same light and will become shy and timid, withdrawing from the society of others, becoming backward in its school work, and declining to make the extraordinary effort needed to overcome its physical handicap.

The face of the child shown in Fig. 642 before treatment exhibits from the physical standpoint the dullness of expression and the mental attributes of weakness and indecision of character that accompany the protruding upper teeth and receding chin, qualities which were entirely

foreign to her character. The malocclusion is a pronounced type of protrusion of the upper anterior teeth of Class I as shown in Fig. 643 before and after treatment, and was the sole cause of the facial disfigurement. Fortunately after the protrusion had been corrected, Fig. 643, a

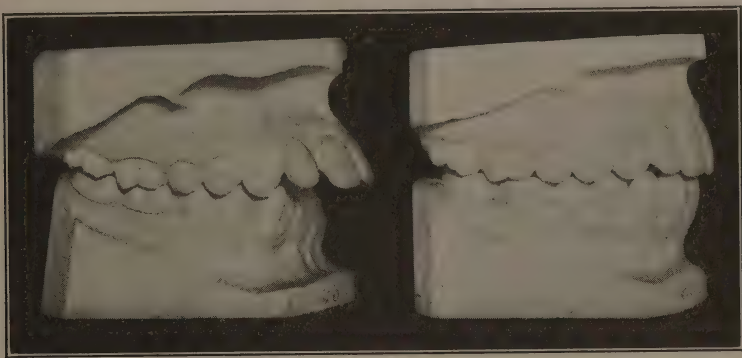


FIG. 643.—Protrusion of class I before and after treatment.

proper balance and harmony in the facial lines was secured and her features exhibited her real physical expression and her true personality as shown in the front and profile views of the face in Figs. 642 and 644.

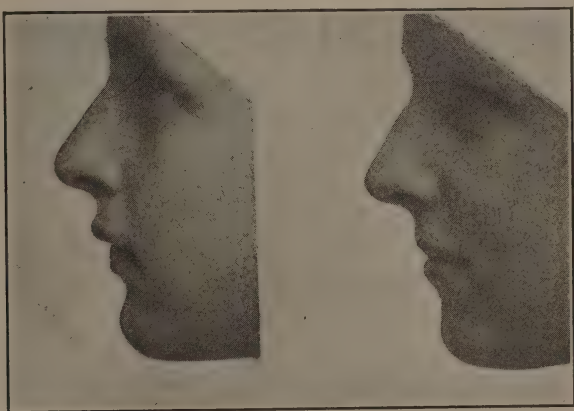


FIG. 644.—Profiles of Fig. 642 before and after treatment.

"In life, personality is the greatest factor. Personality is not a physical attribute, it is rather the imprint of the mental attributes upon the physical frame. The bearing, the figure, the carriage, the race,—express the man, and we judge men and women by these things. The habit of mind will make its stamp upon the face and the judgment which people make from the face will react in the development of character." . . . "A child has no greater right, therefore, than that he should have a fair chance to have his personality make its imprint upon his face—to have

his face become a true expression of himself—but, what are in the truest sense accidents, are continually marking faces with characteristics which are in no way the imprint of personality, but which react upon the individual in the moulding of character. There are thousands of faces that are at once taken to express weakness of character, which at least bear no relation to this mental quality, but are the result of accidental relation of the first permanent molar. How unfair it is that persons should be allowed to grow up and form character with the qualities of indecision, weakness, cynicism, pugnacity, or ferocity attributed to them which are not inherent mental qualities but the result of an accident of occlusion."*

Many of the cases which come under the orthodontist's care, and which exhibit facial expressions unwarranted by their real mental and physical attributes, require a very short period of time and simple treatment in order to change the disfiguring facial lines; others of a more serious nature demand a long period of treatment, an improvement in general health, the eradication of abnormal habits of facial muscles, and the training of the facial muscles so that their proper strength and function will preserve not only the normal relations of occlusion but the proper balance of the face.

The highest conception of the art possibilities in orthodontia, therefore, include the restoration, through the establishment of normal relations of occlusion and the training of the muscles of mastication and expression, of balance and harmony in the facial lines, the attainment of beauty, and the delineation of character and charm in the pleasing expressions of the face, in a word—the development of a pleasing personality.

* The Index of Personality, Frederick B. Noyes, *The American Orthodontist*, April, 1911.

CHAPTER XLIII

QUALIFICATIONS OF ORTHODONTIC APPLIANCES

Adaptability of Modern Appliances.—The appliances used for orthodontic treatment are much more perfectly adapted today for the delicate and complicated work expected of them than were the appliances of even a decade ago, and the continual process of evolution of these appliances to meet modern requirements, the forms which they assume, the materials from which they are constructed, the method of their adaptation to the teeth, and their relative degrees of efficiency, have all undergone a progressive change for the better. This is due primarily to a more enlightened perception of the work that modern appliances in skilled hands should accomplish and the conformation of these appliances to meet modern requirements.

Requirements of Modern Orthodontic Appliances.—In order to understand the qualifications of an appliance for orthodontic treatment it is important that we realize that we are dealing with vital tissues and that we are only trying to so interpret Nature's own method of growth of the dental arches, even to concern ourselves with the metabolism and growth of the individual cell of the osseous structures of the jaws, as to assist rather than to subvert growth of the tissues arrested in development.

This orthodontic assistance must take cognizance of the quality of growth in these tissues, and of the extremely delicate stimuli needed to induce growth therein by means of mechanical appliances. Dr. Hellman has very aptly termed this two fold aspect of the orthodontic problem "biomechanics." "Fusing as this expression does, the mechanics applied in the delivery of a force and the biological manifestation as a result, it at once suggests the movement of teeth as being associated with vital and mechanical processes."*

The development of the dental arches through orthodontic treatment therefore, is brought about by a *biomechanical* process, the biological principles of growth being taken advantage of in the stimulation to growth and restoration of function of the dental apparatus by mechanical means.

In order to properly understand and use an orthodontic appliance this dual purpose of the appliance must never be lost sight of for its work is confined to living tissues, temporarily arrested in growth and function, which under proper treatment may be developed up to a nearly normal

* Mechanics in Orthodontia, Milo H. Hellman, *Dental Cosmos*, Dec., 1920.

standard measured by the attainment of the relations and function of normal occlusion and the full muscular activity of the jaws.

The modern orthodontic appliance, having passed through a long series of evolutionary changes is adapted to meet as nearly as possible the demands made upon it from a physiological, mechanical, and esthetic standpoint.

It must stimulate growth, be unharmful to the tissues, operate with the right mechanical principles and conform to certain established ideas of esthetics, all of which will be discussed somewhat in detail and in sequence.

PHYSIOLOGICAL REQUIREMENTS

Operation Within Physiological Limits.—Necessarily an appliance in conforming to these requirements, must operate within physiological limits, producing only enough pressure applied in the right directions to stimulate growth. This pressure stimulation cannot be definitely measured, but experience has proven that it is the most delicate application of force by appliances attached to the teeth, rather than the opposite. In fact, any overstimulation through undue pressure and rapid movement of teeth has the effect of breaking down rather than building up the osseous structures, and is to be carefully avoided.

Definition of an Orthodontic Appliance.—*This naturally leads us to define an appliance* used for orthodontic treatment as follows: *An orthodontic appliance is a force producing mechanism attached to the teeth in such a manner as to produce, through a gentle pressure in the direction of their normal positions, a physiological stimulation to the investing osseous tissues, whereby growth and development of undeveloped dental arches may be obtained and malocclusions of the teeth be corrected.*

This definition applies more particularly to the treatment of the usual case of malocclusion in which the dental arches are undeveloped or arrested in growth whereby the stimulus of an orthodontic appliance properly attached to the teeth will move them into the "line of occlusion" natural for the normal occlusion of the individual.

Orthodontic treatment which is aimed at the alignment of the teeth after extraction of one or more teeth in adult cases does not take advantage of the principle of pressure stimulation for development of the dental arch, although, if the appliances are operated within physiological limits, the effect of the pressure upon individual teeth in these cases will not be harmful.

Production of Force in Directions of Growth.—The operation of appliance within physiological limits might well include the production of force in the directions of growth in three dimensions of space although this is not always possible.

Interference with Mastication and Speech.—*Appliances must not interfere seriously with mastication* for this function would otherwise be impaired to the detriment of the health of the individual. *Interference* with *speech*, while not so important, needs to be guarded against at all times, and except in rare cases, is not a cause of much concern in the use of a properly applied mechanism.

Construction of Non-injurious Metals.—Appliances must be made of non-corrosive materials non-injurious to the tooth surfaces and to the tissues of the mouth. Corrosive metals, besides being injurious, lose bulk and strength by corrosion.

Observation of Prophylactic Methods.—It is much more difficult to keep the surfaces of the teeth clean during the wearing of orthodontic appliances because of the natural obstruction of the appliances themselves to Nature's own prophylactic methods, and to the use of the tooth brush. If food detritus is allowed to collect upon the tooth surfaces or upon the appliances to any extent, harm is sure to result to the surfaces of the teeth where extra prophylactic methods have not been observed.

Cleanliness of the teeth and the appliance is a final essential in preserving a healthy mouth so that the physiological requirements may be fully observed.

MECHANICAL REQUIREMENTS

Mechanical Requirements of Appliances.—Modern appliances must stand certain tests from a mechanical standpoint such as being capable of the proper character and control of force, having stable attachments to the teeth, constructed of highly elastic metals, and properly formed and located for efficient use.

Proper Character and Control of Force.—In regard to the first of these requirements it may be said that an appliance should be so constructed mechanically that various degrees of force may be delivered from it in the directions of growth of the dental arches, delicately yet positively applied, and at all times under the control of the operator.

Stable Attachments.—Again the attachments of the appliance, especially to the molar teeth must be of a fixed nature in order that the stability of the appliance during delivery of the force may be assured. Instability of attachments means loss of positiveness, intermittent and harmful application of the force, and delay in securing results. Stability of attachments will assure uniform and positive application of the force, which can be augmented by reenforcement of these attachments.

Fixed and Removable Appliances.—Appliances may, therefore, be divided into two forms, *fixed* and *removable*, the former being capable of being removed only by the operator, the latter being easily removed

by the patient. As a rule, the fixed appliance, because of its greater stability, constant application of force, and consequent efficiency, is to be preferred.

Use of Highly Elastic Metals of High Fusing Point.—The mechanical requirements of appliances are further observed in the use of highly elastic metals for arch and spring wires of various forms. The property of elasticity is one of the most valuable in connection with appliances.

Another physical property of the noble metals which render them better adapted for use in orthodontia is that of fusion at high temperatures, which enables the operator to solder attachments of various kinds without being liable to melt the entire work under construction.

The alloys of gold and platinum are best suited for the construction of delicate, elastic, high fusing wires for orthodontic use. A test for a spring wire of proper quality would be a high degree of elasticity and a high fusing point, combined with the quality of non-corrosion. This test would exclude German silver and all of the base metal alloys, for all of them lose temper on annealing and corrode in the fluids of the mouth, although their fusing points are usualy high.

The possessing of usable elasticity is one of the mechanical requirements of appliances which has often been neglected because of its not being understood. In a word, it refers to the proper size and temper of wires for arch wires or auxillary springs. The smaller the diameter of a spring wire the greater the amount of usable elasticity it possesses up to a certain degree beyond which it again has less usable elasticity on account of being too delicate in size to produce enough elastic force as well as being too small to withstand the wear of food mastication without distortion. Arch wires of large diameter such as .038″ or .040″ gauge have less usable elasticity, therefore, than the smaller 025″and .030″ diameter arches.

Proper Form and Location of Appliances.—Orthodontic appliances designed for general dental arch development should follow certain well established forms and locations. Usually they are constructed in the form of the dental arch following its outline labiobuccally or lingually so as to be within range of all of the teeth of one dental arch, and thus capable of their easy control.

ESTHETIC REQUIREMENTS

Esthetic Requirements of Appliances.—The high degree of skill required in the construction of orthodontic appliances would imply a certain amount of attention to the esthetic appearance of these appliances *en situ*, and usually commensurate with the ability of the operator to produce a pleasing effect.

Inconspicuousness is a desirable quality only without too great a sacrifice of efficiency, and yet in a large percentage of simple cases and in

many complex cases appliances may be constructed and located in relation to the teeth so that they are not conspicuous. Examples of these are the lingual arches and the high labial arches.

Delicacy of construction in the use of fine arch wires and narrow bands add to the esthetic effect of a finished appliance, and excessive bulk in appliance parts should be avoided in any case.

Use of non-contrasting metals for construction also aids in securing the artistic effort desired. Iridio-platinum wires and bands because of their color, not contrasting sharply with the teeth, but often blending with their color, are desirable when possible. Alloys of gold and platinum, however, are more generally used on account of their more moderate cost, and having the advantage of non-oxidation so that they do not discolor as do some of the alloys of the base metals.

Simplicity of design as a desirable quality of orthodontic appliances, used to be considered under the mechanical requirements rather than under the esthetic, but on account of the necessary departure of modern appliances from simplicity to a great extent, this quality does not apply with any great emphasis to the mechanical construction.

However, the simply constructed appliance will always possess the esthetic and artistic qualities which are most desirable and it is well to keep the principle of *simplicity of design* in mind and follow it as nearly as possible in the construction of any appliance by the elimination of the non-essential parts.

Mechanical Advantage.—The dynamical features presenting in the correction of malocclusion, require that only that appliance should be used which shall possess the greatest mechanical advantage in its application, and consequently, conserve all of the energy possible, both of force and resistance.

In the conformation of appliances to the principle of the conservation of energy, we must recognize the primary axiom, "the work done by the effort must equal the work done in overcoming the resistance," and that the test of the efficiency of any appliance is the nearest approach to the securing of resistance and application of force which shall be the most useful and the least wasteful of the energy which is being used.

"If a machine could be made which wasted no energy, the resistance being all useful, and not wasteful, the machine would be perfect, and its efficiency would be unity."

Theoretically, we can imagine an appliance for moving teeth, having every mechanical advantage, sufficient resistance in anchor teeth, sufficient and controllable potential, and direct application of its force, with no loss of energy at any point, but in practice we are confronted with such

obstacles as friction, insufficient and unstable resistance, indirect application of force, etc.

Efficiency of Appliances.—The efficiency of any appliance, therefore, can be expressed in a proper fraction, or a percentage of the total amount of energy put into it. Simplicity in construction and operation is a prime factor in the determination of the efficiency of an appliance, since the least number of working parts reduces the amount of friction and other wasteful energy.

The stability or fixation of the basal attachments of appliances, the material of which they are constructed, the size and temper of wires and ligatures, and the amount of power capable of being produced, are likewise essential factors in the efficiency of any force producing mechanism used in orthodontia.

It is obvious that an appliance should not only have the most stable attachments, sufficient resistance to the applied force, which is most direct in its application, but also that the force itself should be great enough and under such control that the time rate, or power of accomplishment of certain desired tooth movements may be somewhat accurately gauged.

The efficiency, then, of an appliance for the correction of malocclusion consists of the fewness and proper proportion of adaptable parts, capable of appropriating sufficient and varied forms of anchorage, and having within its compass the positive control of all of the teeth of one dental arch, conserving time and energy through the proper adjustment of each part so as to secure a perfect working mechanism, and capable of transmitting force as gently and in such quantity as is consistent with physiological maintenance in operations on vital structures.

CHAPTER XLIV

FORMS OF MODERN APPLIANCES

Evolution of Modern Appliances.—The appliances used in orthodontic treatment are undergoing a continual process of evolution. One has but to compare the forms of appliances in use today with those illustrated in the textbooks of a quarter of a century ago to bring this fact forcibly to mind. The older types of appliances were usually constructed of base metals and were bulky and conspicuous, exerting the maximum instead of the minimum of pressure, designed to forcibly push or pull the teeth into alignment often after extracting one or more teeth to "make room."

The appliances were of a removable type generally and were, therefore, only moderately efficient for the work they were designed to accomplish at this early date.

Gradually as the teaching of the possible restoration of normal occlusion became known, the forms of appliances changed to meet the newer conception of the orthodontic problem, and the arch form of appliance was selected by Dr. Angle to control all of the teeth in each dental arch, and to restore the normal relations of occlusion.

The principles of anchorage were evolved, and the fixed appliance, with its positive and stable anchorage came into quite general use, and the application of force was modified to a more gentle pressure stimulus to growth and development of the dental arches.

Orthodontia became a specialty and the clientele of the orthodontist changed from the adult to the child. With this change came also a further refinement of appliances with greater delicacy of construction and minimizing of exerted pressure to meet the demands of the work on growing children. The lingual arch with its greater cleanliness, less interference with the muscles of the mouth, less conspicuousness, and gentle application of pressure stimuli, came into greater use, and today is considered one of the most useful of modern appliances. The objectionable feature of the removable appliance, viz, the lack of fixation, has gradually changed to the fixed type of appliance, while the auxiliary springs so useful in the Jackson form of removable appliance have been adopted in the construction of every form of modern fixed appliances.

Forms of Modern Appliances.—The arch form of appliance is the generally accepted form of modern appliances, varying in shape and size according to its location. Appliances designed for development of the

dental arch must of necessity follow well established forms determined by their location. Usually they are of the shape of the dental arch, following closely its outline labiobuccally, or lingually so as to have all of the teeth in one arch within their range and also to avoid interference with muscular action, mastication, and speech. Occasionally a lingual appliance will be constructed so that it crosses the occlusal embrasures of certain teeth and follows the labial surfaces of some of the teeth so as to exert a labial control, effecting a combination of a labial and lingual arch.

Classification of Modern Appliances.—Modern appliances may thus be divided according to form and location into *labial*, *lingual*, and *labio-lingual arches*.

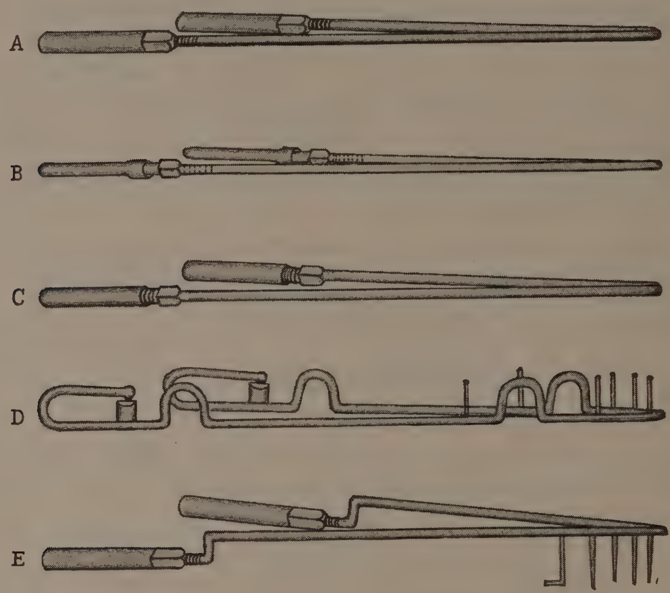


FIG. 645.—Forms of labial alignment arches.

These arches have been termed expansion or alignment arches the latter term being preferred because it is inclusive of both expansion and contraction as applied to these appliances.

These three forms of arches may be modified in various ways, *e.g.*, the labial arch may be threaded or unthreaded, of large or small diameter, located across the labial surfaces of the teeth or high above the teeth within a few millimeters from the gums.

The lingual arch may be of varying diameters, of hard elastic wires, or of soft wire for pinching purposes; the lingual wire may itself act as a force producing mechanism through elongation of properly placed loops in one form, or by pinching in another form. Again, it may act as a base

wire anchorage with its lingual locks for the transmission of force by attached auxillary springs.

Labial Alignment Arches.—Fig. 645 illustrates the most important forms of labial arches in present day use in orthodontia, consisting of threaded and unthreaded alignment arches, some round, one flat, and one bent anteriorly high above the surfaces of the teeth. The threaded arches embody the force principles of the screw, the spring and the lever, and the unthreaded arches those of the spring and the lever.

The labial alignment arches have a more direct and positive control of all of the teeth in each dental arch, and by the use of the intermaxillary force, the control of all the teeth of both dental arches. The form A, the round alignment arch, fitting into round or flat horizontal buccal tubes, is the most universally used appliance in orthodontia, and controls the teeth within its arch by means of ligatures. The form B, the threaded flat ribbon arch devised by Dr. Angle, fits into quadangular buccal tubes on the molar anchor bands and into slots in brackets on anterior tooth bands, necessitating bodily movement of all of the teeth to which it is attached upon the application of the force of the spring and the screw.

The form C, an unthreaded round arch designed by Dr. Varney Barnes, while essentially having the power of the spring and the lever, has the additional force of the screw principle embodied in the long sheath nut threaded into the buccal tube.

The form of arch shown at D, Fig. 645, the pin and tube appliance, embodies the principles of the spring and lever alone, and the half round rod and tube locked on the molar band allows of the removal of the appliance in the vertical plane to correspond with the removal of vertical pins on the anterior portion of the appliance from the tubes on anterior tooth bands. The arch is increased in size by opening the loop in front of the anchor teeth or between the cuspids. This arch can also be used as a plain arch without vertical pins attached. A smaller form of this arch with expanding loops between the cuspids only, is known as the "junior pin and tube appliance."

The form of arch shown at E, Fig. 645, a design of Dr. Lloyd Lourie, and known as the high labial arch, fits into either round or flat buccal tubes and is bent toward the gingivæ in front of the threaded portion on each side and rebent horizontally to pass high above the teeth following closely the line of the gums from one side to the other. Finger springs attached to the arch control the movements of the teeth. This form of arch is inconspicuous and cleanly, giving greater freedom for prophylaxis than the arches placed across the labial surfaces of the anterior teeth. This arch may be constructed without threads also, and be held in position or

made to increase its arc by the attachment of buccal springs anterior to the buccal tubes.

Lingual Alignment Arches.—The alignment arches that operate from the lingual side of the dental arches are quite as diversified in the manner of their application of force although each possesses the same general arch form as are the labial alignment arches. The earlier form of lingual arch consisted of a single lingual wire soldered to anchor bands at its extremities and following closely the lingual surfaces of the teeth in its circumference. This arch wire I, Fig. 646, made of iridio-platinum originally,

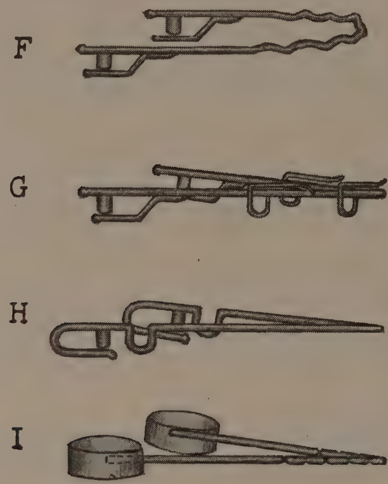


Fig. 646.—Forms of lingual alignment arches.

was designed by Dr. Lourie to be increased in size, thereby developing the dental arch, by pinching with a wire stretching plier in a manner similar to that in earlier use by Dr. Angle in his stretching of a lingual retaining wire. Although this is one of the earlier forms of lingual arches, it is one of the most valuable, being the simplest in form although the most difficult in manipulation of any of the lingual arches.

A later form of lingual arch, Fig. 646 F, is attached to molar bands with lingual locks, the half round rod and lock of Dr. Mershon being the most generally used, and it is increased in size and its developmental power exerted by flattening out the bends in the wire at the points where it has been bent in to fit the embrasures of individual teeth along the line of the arch.

Dr. Mershon has done much to develop the technique of this form of lingual arch as well as the form shown at G in Fig. 646 in which the arch takes the form of a base wire for the attachment of auxiliary springs for tooth movement.

The form of lingual arch shown at H, Fig. 646, is a small gauge arch, .030 in. diameter, locked at its extremities and increasing in size by opening of loops on each side.

Labio-lingual Alignment Arches.—The form of alignment arch which is attached on the lingual side of the dental arch and adapted partly to the lingual surfaces of the teeth and partly to the labial, crossing in occlusal embrasures, usually between the cuspid and first bicuspid, is shown in Fig. 647. Its great advantage lies in its control of the anterior teeth

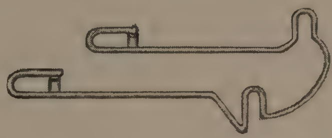


FIG. 647.—Labio-lingual alignment arch.

labially while tooth movements may be carried on from auxiliary springs lingually. It is also an efficient and inconspicuous retaining appliance.

Various other modifications of the three types of appliances are in use and the more important ones will be described in the text in connection with the treatment of cases.

CHAPTER XLV

THE MECHANICS OF ORTHODONTIA

Mechanics a Relative Factor in Orthodontia.—In accordance with the dual aspect of orthodontic treatment, already mentioned, viz., the action of forces obtained from appliances upon vital tissues and their physiological rather than mechanical response to such stimuli, it is impossible to explain the action of these forces from a mechanical standpoint alone, and yet the forces used and their actions, in so far as the appliances themselves are concerned, are amenable to the same laws and principles of mechanics which govern the action of forces in general.

Physical Limitations of Applied Forces.—The limitations, however, in the quality and quantity of the applied forces, because of the danger of injury to the membraneous and osseous tissues involved, present a striking contrast to the application of similar forces in the field of general mechanics where physiological and pathological considerations are unknown, and where force and resistance may be accurately measured. In the field of applied mechanics in the arts, a force operating from an unstable resistance would not be considered practical, but in the application of forces to the dental and aveolar tissues, the "biomechanical" problems in the development of the dental arches are not infrequently solved by the operation of forces from a more or less unstable base.

For example, it may happen that the resistance to applied forces may be located in the anchor teeth which are at the same time being moved in a direction opposed to or at right angles to the applied forces.

Hence, stability in applied forces or in the resistance to these forces in the mouth, can never be regarded in the absolute, but it must be theoretically assumed in the mechanics of orthodontia in order that the nearest approach to absolute stability that can be obtained may allow of the application of certain of the principles of mechanics.

The use of orthodontic appliances without a fundamental knowledge of these mechanical principles would be, therefore, not only unscientific and empirical, but also, on account of the nature of the tissues involved, productive of more or less serious consequences in the treatment of malocclusion.

Modern Conception of the Action of Orthodontic Appliances.—The operation of appliances upon the teeth has usually been regarded as a simple problem in physics or mechanics whereby the *action* or *force* of the

appliance was opposed by the *reaction* or *resistance* offered by the teeth and their supporting structures, and conformative to Newton's third law of motion that "*action and reaction are equal and opposite.*" Recently this idea of the operation of appliances on the teeth has come to be somewhat modified through a new conception of the actual dynamical considerations involved. Professor Pupin of Columbia University, an eminent physicist, has introduced a new term, *interaction*, to fill the gap between *action* and *reaction* in explanation of the action of undefinable and unmeasurable forces which are active between the *action* and *reaction* of other forces when applied to vital processes.

Dr. Milo Hellman,* in a recent monograph, applies this new term *interaction* to the action of orthodontic appliances as follows; "Thus, when an appliance is utilized for orthodontic purposes, the result consists in a modification of the alveolar process. This modification in turn consists of an increase or diminution in magnitude of the tissues constituting the alveolar process for the favorable accommodation of the teeth. In proportion as the alveolar process changes in magnitude, the teeth will change in position. As observed, there is a considerable lapse of time between the application of the force and the response of the teeth. During this lapse of time, there is an *interaction* going on within the circulatory and nervous systems, the peridental membrane and the osseous tissue surrounding the teeth. These tooth supporting tissues *interact* in a manner to prepare the way for a change in the position of the tooth. Moreover, while the acting and reacting parts respond apparently with mechanical principles, the *interacting* media respect more the biological laws: Thus, comparatively insignificant amounts of force exerted by the delicate appliances produce enormous changes in the growth of the alveolar process."

With this interpretation of the operation of orthodontic appliances and the *action*, *interaction* and *reaction* of forces in the development of the dental arches, a proper understanding of the actual dynamical considerations involved is assured, even though the interactive forces may not be otherwise defined or measured in a further explanation of the application of the principles of mechanics to orthodontia.

Force and Resistances.—A proper consideration of these mechanical principles would be embodied in a study of the action of *forces* upon the teeth and dental arches produced by the simple machines and their combinations, and in a study of the quality of reaction or *resistance* to these forces inherent in the teeth, or the structures in which they are imbedded, as well as the possible interactive forces.

The relations of *force* and *resistance* in the application of mechanical appliances for the development of the dental arches, or for the correction

* Mechanics in Orthodontia, from a Modern Aspect, *The Dental Cosmos*, Dr. Milo Hellman, December, 1920, p. 1390.

of malocclusion, then, represent the elementary basic factors, which, in the attainment of desired results in orthodontic treatment, must be considered separately and together in order that the proper construction of appliances and the attainment of their highest standard of efficiency within physiological limits may be secured.

In the consideration of these factors, it must be remembered that applied force is active, and to a degree directly opposed to the other factor, resistance, which is passive or latent energy, incapable of being measured, except by the corresponding degree of active energy necessary to overcome it in the applied force.

The application of active and interactive forces in orthodontia is properly considered under the general head of **Orthodontic Dynamics**; the study of the reaction or resistance to these forces under the commonly known designation of **Anchorage.**

CHAPTER XLVI

THE MECHANICS OF ORTHODONTIA CONT'D

ORTHODONTIC DYNAMICS

Orthodontic dynamics may be defined as *the action and interaction of applied forces in the mechanics of orthodontia*. Before considering the application of these forces it may be well to enumerate the requirements of tooth movement as indicated by the various malpositions of teeth or malocclusion of the dental arches.

Dynamical Requirements in Orthodontia.—In order to conform to the directions of growth in the dental arches it is necessary that force be produced by appliances in the three dimensions of length, breadth, and height. Again, force-producing appliances must operate to produce mesial or distal changes in occlusion.

Further, these appliances must be capable of producing forces which shall operate to correct malocclusion in the positions of individual teeth.

Effect of Force on Tooth Movement.—The action of force upon the teeth is entirely dependent upon the magnitude of the force, and its direction, as indicated by the manner of its application. A study of the manner of application of force upon teeth to be moved will reveal five distinct methods of tooth movement, viz., *inclination*, *bodily*, *rotating*, *extruding* and *intruding* movements as designated by Dr. C. S. Case.

Inclination *movement is that action of a force upon the teeth whereby their crowns are tipped into new occlusal relations.*

An example of inclination movement of a tooth is diagrammatically shown in Fig. 648, in which the crown of the incisor is moved from A to B the apex C not being appreciably changed in position, except through the developmental tendency increased by the stimulation of treatment. *Inclination* movement is obtained in the incisor region by ligating the teeth to the alignment arch as in Fig. 720, and in the molar region by the use of round buccal tubes on molar bands.

Bodily *movement is that action of a force upon the teeth whereby they are moved bodily in the horizontal plane.*

This method of tooth movement is illustrated in Fig. 649 by a force acting equally at right angles to the central axis of a tooth changing its position from EG to JH an equal distance apicably and coronally.

Bodily movement is secured in the incisor region by the use of vertical rods fitting into tubes on the incisor or bicuspid bands as in Fig. 793, by the use of a ribbon arch fitting into brackets on bands as in Fig. 677 or by the use of compensating double alignment arches (Fig. 687) (Case). In the molar region *bodily* movement is secured by the use of buccal tubes which do not allow of rotation of the alignment arch as in Fig. 696.

FIG. 648.—Inclination movement.

FIG. 649.—Bodily movement.

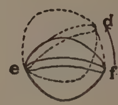


FIG. 650.—Rotating movement.

Rotating *movement of the teeth is that action of a force upon the teeth whereby they are rotated upon their central axes.*

This movement of teeth is illustrated in Fig. 650 by a force acting in the horizontal plane tending to turn the tooth on its central axis from f to d.

Extruding *movement is that action of a force upon the teeth whereby they are moved coronally in the line of their central axes.*

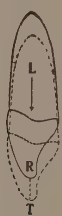


FIG. 651.—Extruding movement.

FIG. 652.—Intruding movement.

In Fig. 651 this action of a force L upon a tooth is indicated by its movement from R to T in the vertical plane.

Intruding *movement is that action of a force upon the teeth whereby they are moved apicably in the line of their central axes.*

This action of a force, being the reverse of extrusion, is indicated in Fig. 652 by a force N directed apicably, causing the tooth to move from E to D in the vertical plane.

Elementary Force-producing Machines.—The forces required for tooth movement, which have been found most adaptable to the conditions in the mouth, are embodied in the principles of the following simple machines: the **inclined plane,** the **screw,** the **spring,** the **lever,** and the

wheel and axle. Auxiliary forces are obtained from the **elasticity** of **rubber,** the **contraction** of **moistened silk,** and the **elasticity** of **stretching** of **soft wire.**

The Inclined Plane.—The simple inclined plane, adapted to single teeth, as shown in Fig. 653, is seldom used today as an independent force principle, on account of its relative inefficiency. Its action is dependent entirely upon the closing of the teeth together firmly in occlusion, and as soon as the teeth become tender from this pressure, the action of the occluding force is voluntarily withdrawn.

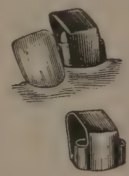


FIG. 653.—Simple inclined plane. (*Guilford.*)

However, in combination with other forces such as the use of intermaxillary force in connection with the inclined plane as in Fig. 880, or used as an independent force principle in the control of the overbite and the correction of infraversion, the force of the inclined plane has a definite value.

The Screw.—The *screw* is a modified *inclined plane*, and its power being under the control of the operator, is direct and positive. There are several forms of appliances in which the principle of the screw is used in orthodontia; viz., the jackscrew, the traction screw, and the alignment arch.

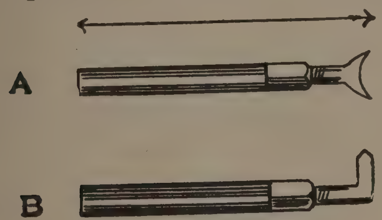


FIG. 654.—Jackscrews.

FIG. 655.—The traction screw.

The jackscrew is shown in Fig. 654 in two forms, A and B. The original form A has fallen into disuse because of its faulty anchorage, the fish-tail end being intended to rest against the lingual surface of an unbanded tooth, or in a groove cut in the enamel, both of which procedures are contraindicated in modern practice. The form B, having a right-angled end which engages with a short horizontally or vertically placed tube on a cemented band, is the more efficient form of jackscrew used at the present time. It operates in the direction of length only, exerting a pushing force as indicated by the double arrow.

The traction screw C, as improved by Angle, exerts a pulling instead of a pushing force as shown in Fig. 655, and is used either alone or in combination with the alignment arch.

The arrows indicate the only possible direction in which it exerts force, parallel to its length, hence its use is limited to closing up spaces

between teeth, or in moving a tooth of lesser resistance toward a tooth of greater resistance.

The threaded **alignment arch** embodies the screw principle in combination with the spring and lever as described under the dynamics of the alignment arch.

The Spring.—The forces exerted by the spring are *forces of elasticity*, and are exhibited in so many of the different forms of modern appliances that their analysis is of especial importance. The forms of elasticity of the spring are of two kinds, the *elasticity of flexion*, or bending, and the *elasticity of torsion*, or twisting.

Elasticity of flexion *is the tendency of a spring wire to return to its original form after bending.*

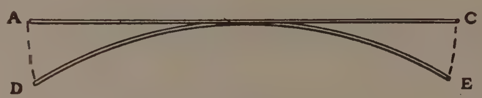


FIG. 656.—Elasticity of flexion of a spring wire.

This form of elasticity is shown in Fig. 656 by a spring wire AC, which, when its ends are held between the thumb and finger may be bent in the arc DE, and upon releasing the pressure, will quickly return to its original form AC. This force of elasticity in the spring is taken advantage of in the alignment arch, and in the elastic lever.

Elasticity of torsion *is the tendency of a spring wire to untwist after torsion* (similarly to the untwisting of a rubber tube after being twisted lengthwise).

The elasticity of torsion may be illustrated in the outward twist that is given to the end of an arch wire, Fig. 657, so that when inserted in the vertical tube, it will tend to move the root of the tooth to which it is attached in the arc of a circle.

FIG. 657.—Elasticity of torsion of a spring wire.

This principle is also used in the torsion of the base wire on both sides of a pin on the pin and tube appliances, as in Fig. 658, the effect being to change the angle of the pin, to effect the outward movement of the root of a tooth.

This torsion may be obtained through the use of two pairs of the pliers shown in Fig. 659, or through the use of torsion pliers designed by the author for the purpose, and shown in Fig. 658. The plier B with the slotted end is used to grasp the base wire **de** firmly, and the plier A to twist the base wire on each side of the upright pin within the divided nose of plier B. A slight circular motion is given to the plier A and the wire at the base of the pin is twisted, thus giving the pin a new angle of inclination.

The Lever.—The force of the lever is one of the most common in use in orthodontia. In combination with the spring of the alignment arch or with spring wires of other sorts it has a definite force value. Its

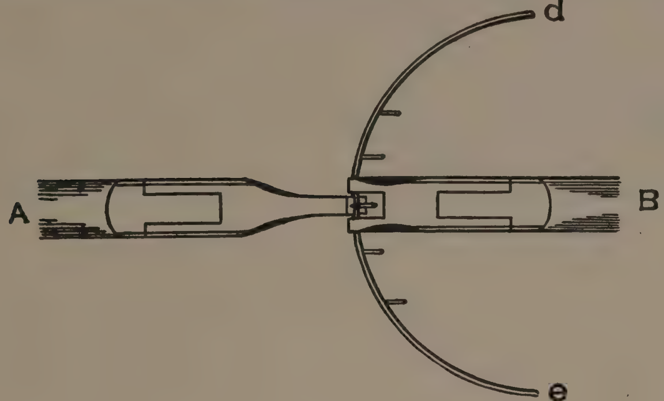


FIG. 658.—Elasticity of torsion of base wire of pin and tube appliance.

form as a spring lever for rotation of individual teeth in connection with the alignment arch is shown in Fig. 771. The ends of the lever fitting in the square tube on the band of the tooth to be rotated should be

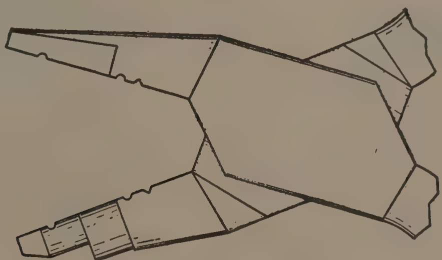


FIG. 659.—Wire bending and torsion pliers. (*Design of Dr. J. Lowe Young.*)

square so as not to allow of any turning of the lever within the tube. The other end of the lever should be bent into the shape of a hook to engage with the alignment arch as shown in Fig. 660.

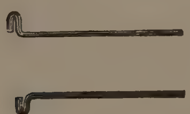


FIG. 660.—Alignment arch levers.

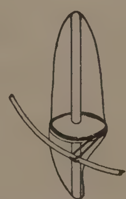


FIG. 661.—Principle of the wheel and axle in tooth rotation.

The Wheel and Axle.—The principle of the wheel and axle is in common use in orthodontia in the ligating of teeth for rotation. This is

diagrammatically shown by the arrangement of the slip noose ligature in Fig. 661. The point of application is represented by the end of the slip noose on the lingual side of a tooth, the ends being ligated to the alignment arch. The force exerted by the contraction of the silk ligatures is in the direction of the arc of a circle, or in effect the same as if applied to the crown (wheel) and exerted upon the smaller diameter (axle) of the root.

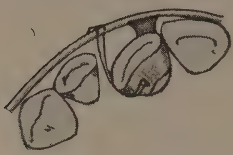


FIG. 662.—Elasticity of compression with rubber wedge.

The same principle is utilized with the wire ligature attached to a lingual spur on an incisor band.

The Elasticity of Rubber.—The force produced by rubber in the movement of teeth is due to its elasticity, which is exerted in two ways, by *compression*, and by *traction*, or pulling. *Elasticity of compression* is produced by the rubber wedges placed between the alignment arch and the mesial or distal angles of incisors to assist in rotation, as shown in Fig. 662.

The *elasticity of traction* is exemplified in the use of elastic rubber rings for producing either *interdental*, *intermaxillary*, or *occipital* force.

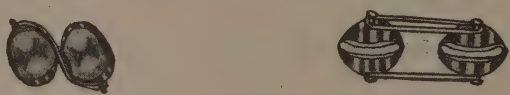


FIG. 663.—Interdental elastic force.

Interdental elastic force is a term, coined by the author, to designate the traction force of elastic rubber rings used between teeth in the same dental arch as illustrated in Fig. 663.

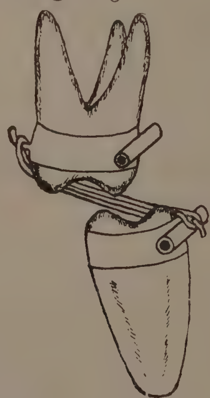


FIG. 664.—Intermaxillary force.

Intermaxillary force is the commonly used term to designate the use of the elastic force of traction rubber rings between teeth of opposing dental arches.

Its use varies from the simple extrusion of an incisor to the mesio-distal shifting of the occlusion of the teeth of both dental arches.

Fig. 664 illustrates its use in the bucco-lingual shifting of the occlusion of the molars. In Fig. 828 it is applied at a number of points along the line of the arch for correcting infraversion.

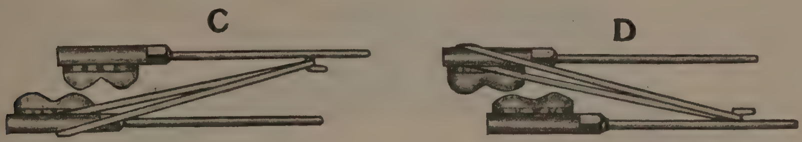


FIG. 665.—Intermaxillary force in mesial and distal shifting of occlusion.

For shifting the occlusion antero-posteriorly, it is applied as at C, for Class II, and as at D for Class III, Fig. 665. Occasionally it is applied across the front of the dental arches as in Fig. 666 when a mesial or distal force is required.

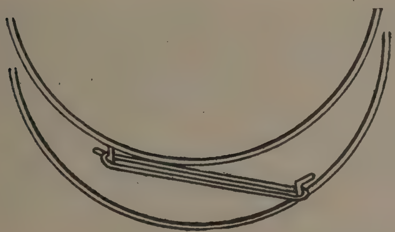


FIG. 666.—Intermaxillary force applied across the anterior part of the arch.

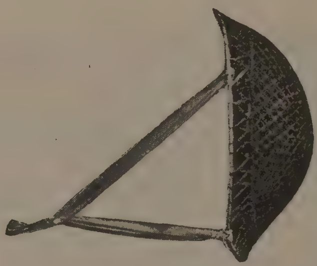


FIG. 667.—Occipital force.

Occipital force is obtained by the use of heavy elastic bands attached from the headgear to the ends of a labial traction bar, which is attached to the alignment arch on the teeth as in Fig. 667.

Contraction of Moistened Silk.—The force obtained by the contractile quality of silk cord in the mouth is taken advantage of in the use of silk

FIG. 668.—Increase in length of wire A to length B by pinching.

ligatures for the movement of the incisors and cuspids. They are especially valuable in rotation of teeth using the principle of the *wheel and axle* as in Fig. 661.

Elasticity of Stretching of Soft Wire.—Advantage is taken of the lengthening of soft wire by pinching to exert force between teeth on

opposite sides of the arch, or for development of the entire arch by the use of a curved pinched wire attached between two teeth the reciprocation

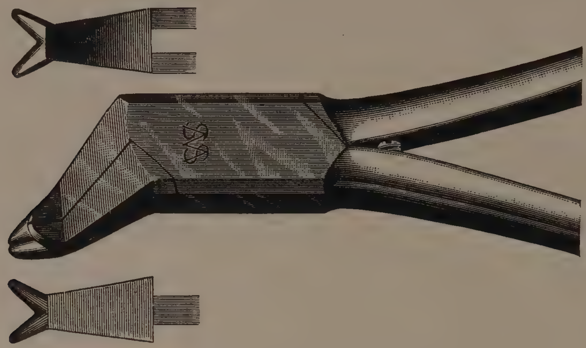


FIG. 669.—The Angle wire stretching plier.

of movement of which is desired, the wire is stretched so that it exerts a gentle force in the directions of its extremities. Fig. 668 A illustrates a

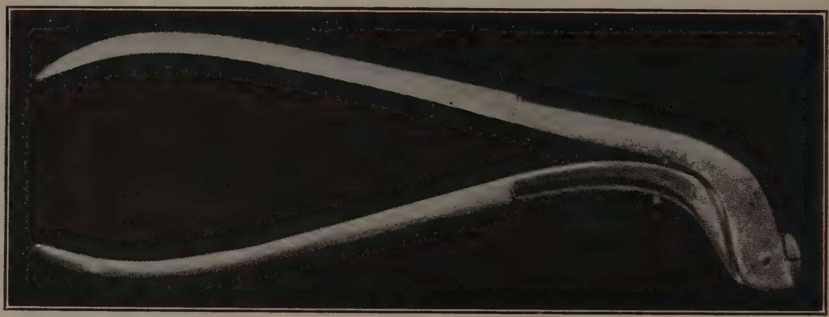


FIG. 670.—The Lourie wire stretching plier.

pinched wire A which has increased in length to that of B by pinching with a wire stretching plier, exhibiting the elastic stretching force. Fig. 669 exhibits the Angle wire stretching plier and Fig. 670 the Lourie wire stretching plier designed for use in such cases.

CHAPTER XLVII

THE MECHANICS OF ORTHODONTIA—CONT'D
DYNAMICS OF VARIOUS FORMS OF APPLIANCES

Form of Appliances as Related to Dynamics.—As has been previously stated, the appliances in use in orthodontia can be divided into three general forms, *labial*, *lingual*, and *labio-lingual* arches, according to their location, and the dynamics of these forms varies somewhat with their variation in form and location. Taking up the first of these general forms, the *labial* arches, the dynamics of the plain alignment arch with threaded

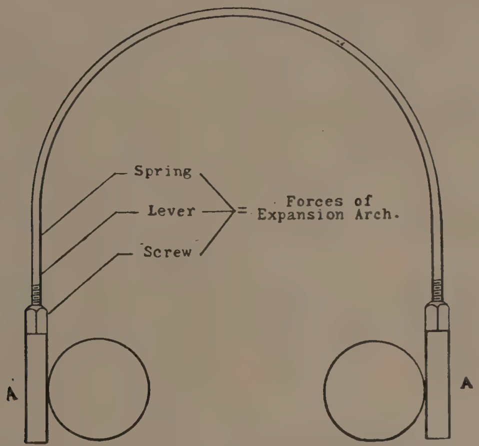


FIG. 671.—Inherent forces of the alignment arch.

extremities will be considered and in succession the various other forms of arches.

Dynamics of the Labial Threaded Alignment Arch.—The **inherent** forces of the alignment arch, Fig. 671, are the forces of the *spring*, the *screw*, and the *lever*. The **auxiliary** forces to the alignment arch, which with the *inherent* forces give it the greatest range of usefulness of any known appliance, are the forces of *auxiliary springs*, of the *elasticity of rubber*, and the *contraction* of *moistened silk*.

The most important of the *inherent* forces of the alignment arch is the elastic force of the *spring*, the principles of the *screw* and *lever* being secondary to the main force of elasticity. The principle of *elasticity*, as related to the alignment arch, is its tendency to return to its original form of a straight wire after bending, thus producing forces of various

degrees of intensity according to the diameter of the spring wire, and the material from which it is constructed.

Gauge of Alignment Arch as Related to Elasticity.—The elastic qualities of the narrower gauges of alignment arches, as for example, the .025 inch and .030 inch arch, can be utilized to much better advantage than those of larger diameter, since, while they are in reality no more elastic, yet the elastic force is more readily available for use with delicate ligatures. In other words the smaller gauge arches possess more *usable elasticity*.

In this connection it will be observed that the choice of a metal or alloy which is the most elastic, and which undergoes no chemical change in the mouth, as gold, platinum and their alloys, is of special value in an alignment arch, for upon these qualities depend the efficiency of the appliance.

Production of Force in Three Dimensions with the Alignment Arch.—In the drawings of the alignment arch in Figs. 672 and 673, it may be observed that force may be produced with it in both the horizontal, and vertical planes by the use of the spring and screw power. The dental arch may thus be lengthened, widened, and developed vertically corresponding to the natural directions of development in three dimensions of space with the alignment arch, utilizing forces which can always be under the control of the operator.

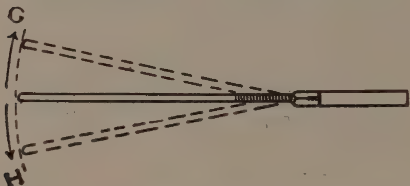


FIG. 672.—Exertion of force in vertical plane.

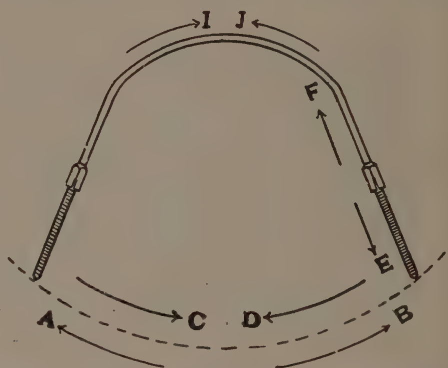


FIG. 673.—Exertion of force in horizontal plane.

Designation of Lateral Force of the Alignment Arch.—In the simpler cases of malocclusion it is seldom necessary to exert lateral force on the molar anchor teeth, hence the alignment arch should be inserted in the buccal tubes in a passive state, which is determined by the paralleling of the arch wire with the buccal tubes when it is laid above or below the tubes. When, however, either a bucally or lingually exerted force is exerted on the anchor teeth it should be designated as suggested by Dr. J. Lowe Young on the treatment chart by letters and numerals as follows; as shown in Fig. 674.

P = O or passive state of arch.

B^1 = Slight buccal force.

B^2 = Medium buccal force.
B^3 = Great buccal force.
L^1 = Slight lingual force, etc.

The use of the spring balance for measuring the force of the alignment arch has been suggested by Dr. C. A. Hawley.

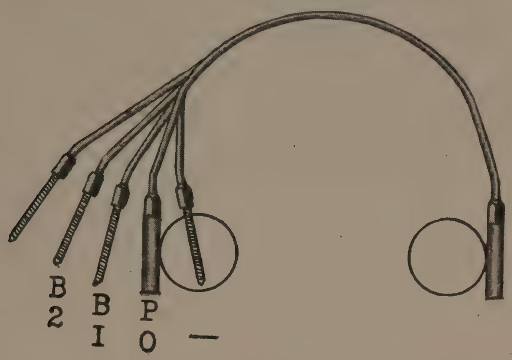


FIG. 674.—Designation of lateral force of alignment arch.

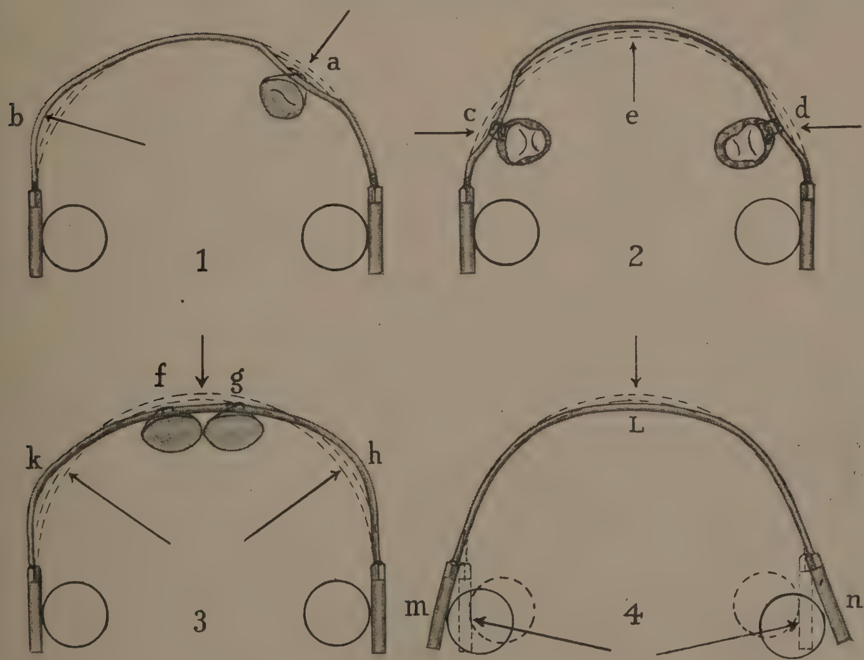


FIG. 675.—Dynamics of the labial alignment arch.

Utilizing the Dynamics of the Labial Alignment Arch.—When the alignment arch is passively placed in position in the buccal tubes on anchor bands without any lateral spring force, and one or more teeth along the line

of the arch are ligated thereto, a change in form or position of the alignment wire is immediately made as shown in diagrams 1, 2, and 3, Fig. 675.

For example, if the cuspid is ligated to the arch in diagram 1 at **a** the arch wire bends inward at this point, but it has also to bend outward at some other point as at **b** to compensate for it. Part of the elastic rebound of the arch wire is thus transferred from **a** to **b,** and the force for moving the cuspid is not as effective as it would be if a cuspid or bicuspid on the b side of the arch were ligated to balance and increase the force exerted at **a.**

This counterbalancing of the force exerted by the alignment arch is taken advantage of in the reciprocation of force from one lateral half to the other in dental arch development. In simple, it is shown by the reciprocation of the force between the points **c** and **d** on the arch wire in diagram 2, Fig. 675, when the two cuspids on each side of the dental arch are ligated. It will be noted that the arch wire bows labially at **e** under these equal lateral stresses slightly beyond the original alignment of the

Fig. 676.—The divided alignment arch.

wire. It is thus seen that the simultaneous ligation of some of the incisors will result in their labial movement provided that the molar anchorage is not strained.

If the incisors alone are ligated to the passively aligned arch as at **fg,** in diagram 3, Fig. 675, the arch wire will bow out at **k** and **h,** and the return of the elastic alignment wire to its original form will move the two incisors labially.

If the alignment arch is placed in the buccal tubes with some degree of lateral spring as in diagram 4, Fig. 675, the molar teeth will move in the lateral directions **m** and **n,** and the front of the arch wire will flatten lingually. Advantage is take of this shortening and flattening tendency of an alignment wire when placed in position with some degree of lateral spring to move the incisors lingually.

Dynamics of the Divided Alignment Arch.—The principle of the divided alignment arch, Fig. 676, depends on the use of an extra set of

jackscrews inserted in the center of the arch. This style of arch, designed by the author, has the power of four jackscrews, and at the same time retains much of the elasticity of the plain alignment arch. It can be made to exert force in the directions of the arrows in Fig. 676. Its especial advantage, however, is in the positive lateral force exerted by the central screw when the nuts are turned up against the central tube. The divided arch is useful only in extreme cases of lateral development in adult cases and in opening the maxillary suture.

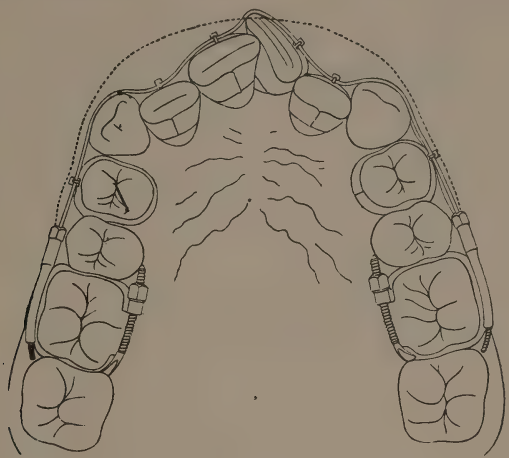


Fig. 677.—Dynamics of the ribbon arch.

Dynamics of the Angle Ribbon Arch.—The ribbon arch combines the same force principles as the round wire arches, the screw, the spring, and the lever, but by means of its delicacy, being only .022 inch in width, and temper, it possesses usable elasticity to a high degree. Also, the ribbon arch, by virtue of its slotted bracket attachments to individual tooth bands, moves the teeth to which it is thus attached bodily, as shown in Fig. 677. The buccal tubes for its attachment to the molar bands accurately fit the ribbon arch, thus securing bodily movement in the anchor teeth when desired. By slightly bending the angles and curves of the arch wire at intervals, and only one or two of these bends at a sitting, the perfect arch form for the malocclusion is finally restored as indicated by the dotted line in the drawing.

Dynamics of the Threadless Labial Alignment Arches.—The threadless alignment arch owes its modern origin to the ingenuity of Dr. Ainsworth who described the use of an unthreaded alignment arch bent at right angles at its extremities, and fitting into round vertical tubes, B, Fig. 677. A loop was added in front of the anchor tube to allow of increase in the size of the arch wire. This arch in a modified form, reconstructed by Drs.

Barnes, Young, and others, is in quite general use today in the form shown at C, Fig. 677 A, in which a half round rod and tube is used for the anchorage attachment and a loop in front of this attachment utilized for the increase of size of the arch as well as increase of force within its circle, thus exhibiting a different form of dynamics from the threaded arches using the principle of the screw. The plain threadless arch without pin and tube attachment depends upon the principle of the spring and lever for the production of force for the movement of teeth by inclination movement,

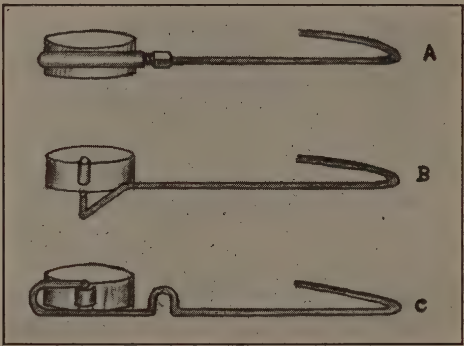


FIG. 677 A.—Dynamics of threadless arches.

although providing for bodily movement of the anchor teeth by the vertical tube attachment.

The threadless alignment arches vary also from the plain threaded alignment arches in their *elasticity* being *usable* the entire length of the arch in front of the anchor teeth on account of their lack of threads and in the use in one form of the loop for increasing the size of the arch.

FIG. 678.—The pin and tube arch.

The Barnes arch, a section of which is shown at A, Fig. 677 A, is very similar in its dynamical possibilities to the plain threaded arch as it is supported by a horizontal buccal tube, internally threaded for the long threaded sheath of the nut which operates to lengthen or shorten the arch. Arches of very small diameter may be used with this special supporting sheath and tube and all of the elasticity of the arch wire be used.

Dynamics of the Pin and Tube Arch.—The pin and tube arch is a modification of the three piece sectional pin and tube arch devised by Dr. Angle for the delivery of force for *bodily* movement of teeth. It is diagrammatically shown in Fig. 678, in which it will be observed that without the

upright pins, etc., it is similar to a plain unthreaded arch of small diameter. It is possible to deliver force from it in the directions of the pins, and in various intermediate directions, similarly to the delivery of force by the plain arch, but, in the use of the soldered upright pins, the character of the force delivered is changed from *inclination to bodily* movement. The opening of the loops delivers force to the anterior section, which is transmitted uniformly to the upright pins in the same horizontal plane, and these pins, being attached to vertical tubes or incisors, cuspid, or bicuspid bands, move these teeth bodily forward or outward in line with the delivered force.

By bending the pins or twisting the base wire, the pins may be made to exert force in an arc tending to move the apical end of the tooth in the same arc.

The difference in the manner of delivery of the force between the plain arch and the pin and tube arch is seen in Fig. 679, the crown of the

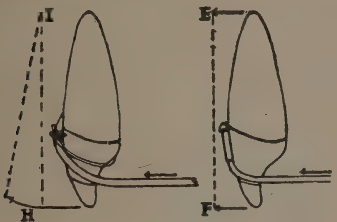


FIG. 679.—H, Inclination movement. F, Bodily movement.

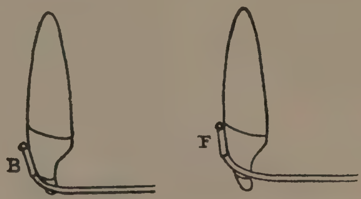


FIG. 680.—B, Improperly placed tube or incisor band. F, Properly placed tube near gingival edge of band.

tooth on the left, being ligated to the plain arch, is being moved by *inclination* movement, in the direction of the arrow H, the apex I remaining in the same relative position; the tooth on the right, being attached by the vertical tube and pin to the pin and tube arch, is being moved *bodily* in the direction of the arrows E and F, the apex of the root moving equally as fast as the crown.

Economy of Force with Pin and Tube Arch.—On account of the increased resistance to tooth movement when moved *bodily* than when moved by *inclination movement*, it is necessary to conserve all of the delivered force by attaching the vertical tubes as near the gingivæ as possible, thus lessening the resistance to bodily movement as in Fig. 680 B, showing an improperly placed tube, and F, a correctly placed tube on an incisor band, fitted close to the gingiva.

Auxiliary Springs on Pin and Tube Arch.—The impracticability of attaching the pin and tube bands to erupting teeth because of the interference with their development is overcome by the use of dainty finger springs, Fig. 681, soldered to the arch wire, as illustrated by Dr. E. S.

Butler. These finger springs can be positively controlled and directed by bending and increasing the torsion of the spring occasionally, and this

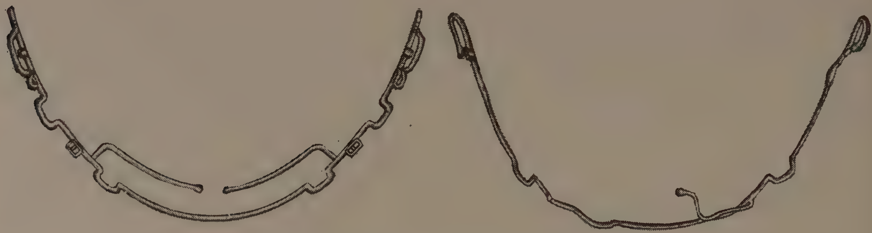


Fig. 681.—Auxiliary springs on pin and tube arch. (*Butler.*)

method of moving erupting teeth into position is very generally accepted as ideal in the use of the pin and tube appliances.

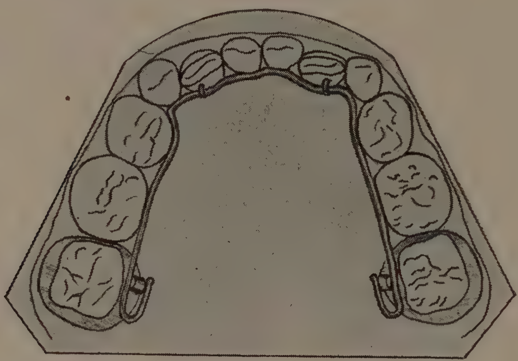


Fig. 682 —The indented lingual arch without auxiliary springs.

The "junior pin and tube" appliance is a duplicate of the pin and tube arch except that it is adapted to the deciduous and mixed dentures, and is

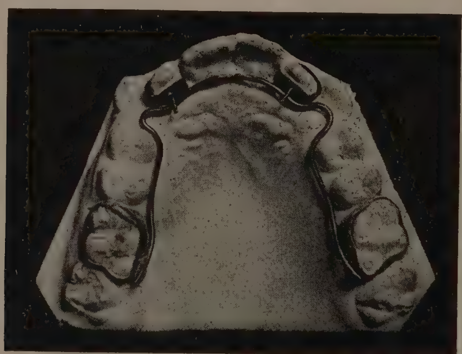


Fig. 683.—The indented lingual arch without auxiliary springs.

therefore, a much shorter arch with, however, the same dynamical principles.

Dynamics of the Lingual Arches.—The lingual arches all possess the principles of the spring and the lever, except the pinched wire arch. In one form of the lingual arch suggested by Dr. Mershon, Figs. 682 and 683, force for developing the dental arch is obtained by gradually flattening out the bends of the lingual arch wine thus increasing the size of the lingual

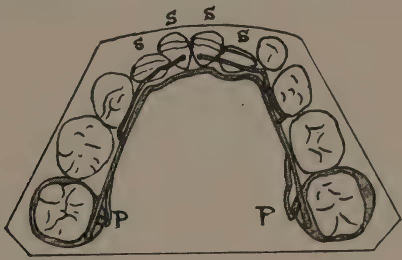


FIG. 684.—Lingual arch with auxiliary springs.

arch and exerting lateral and forward pressure upon the teeth. While this lingual arch can be removed by the operator by unlocking the lingual lock, it is not a removable appliance. The character of the force may be rendered still more positive at the points of delivery by banding one or more of the anterior teeth.

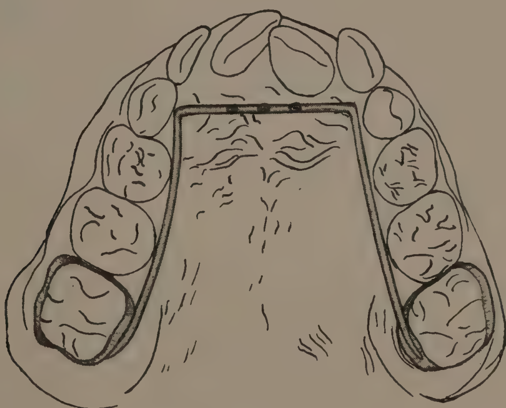


FIG. 685.—The pinched wire arch adjusted for arch development.

The lingual arch with auxilary springs, also developed by Dr. Mershon, consists of a base wire of sufficient elasticity to exert lateral pressure in the molar region, and to rotate the molar teeth through its attachment by the half round rod and tube, Fig. 684. The attached auxiliary springs, however, take care of the movement of groups of the teeth enclosed by the arms of the springs and develop the anterior part of the dental arch.

The pinched wire arch, Figs. 685 and 686 introduced by Dr. Angle and developed by Dr. Lourie, exerts its force for moving teeth or for developing

the dental arch through the lengthening of the arch wire by pinching with specially made pliers. While malpositions of individual teeth may be corrected with this arch, it is of greater use in exerting a gentle but continuous pressure for development of the dental arch. The control of the force with this arch is very difficult to direct without some experience in its use.

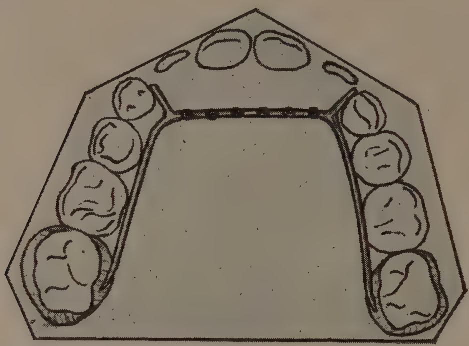


FIG. 686.—The pinched wire arch with extensions. (*After Lourie.*)

Dynamics of the Labio-lingual Arch.—The labio-lingual arch, Fig. 647, possesses the force principles of the spring and the lever, and can exert lingual pressures from the extremity of the base wine laterally, although the auxiliary springs along the lingual side of the arch may exert lateral pressure on the anterior teeth through the labial extension.

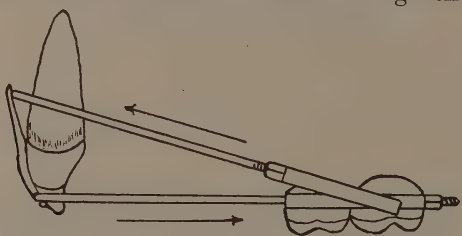


FIG. 687.—Double reciprocating alignment arches. (*After Case.*)

Dynamics of the Double Alignment Arches.—The principle of the double reciprocating alignment arches, which were first illustrated and described by Dr. C. S. Case, presents an unique and economical method of applying force for *bodily* movement of the teeth, although the apparatus is considerably less delicate than the pin and tube arch. The power arch, in Fig. 687, delivers force to the "rigid rootwise extension," and the fulcrum arch exerts a traction force lingually upon the edge of the incisor in the direction of the molar anchorage, where these forces are neutralized, if equal. The result of this reciprocation of force and its application tend to move the root of the incisor labially, while the crown is moved lingually, or prevented from moving forward.

CHAPTER XLVIII

THE MECHANICS OF ORTHODONTIA CONT'D
ANCHORAGE

Anchorage a Study of Resistance Values.—Anchorage deals entirely with the factor of resistance to applied force in orthodontia, and it its consideration the resistance values of the teeth, singly and collectively, their location, size, and number of roots, their lesser resistance to mesial than to distal movement, the relative thickness of the alveolar process, and the varying degrees of its density according to age, must all be taken into account. Anchorage is thus a question of comparative resistance values of the teeth, singly or in combination.

Resistance, although latent, is nevertheless energy, and the degree of one's success in the restoration of harmony in occlusion and facial lines is to a great extent dependable upon the intelligent use of this inert energy, which should always be accurately proportioned to the dynamical requirements in dental arch development.

In regard to the mechanical requirements of anchorage, the limitations in the quality and quantity of the applied force, because of the danger of injuring the living tissues involved, present a striking contrast to the application of similar forces in the field of general mechanics where resistance may be accurately measured and scientifically adjusted so that its stability in relation to any dynamical requirements may always be positively known.

In the field of applied mechanics in the arts, for example, a force acting against an unstable resistance is not considered within the limits of practicability, but in the application of dynamics to living dental and alveolar tissues, the mechanical problems in the development of the dental arches and correction of malocclusion are not infrequently solved by the operation of a force acting from a more or less unstable base.

Stability in applied forces, or in the resistance to these forces in the mouth, can therefore never be regarded in the absolute, but it must be theoretically assumed in the mechanics of orthodontia in order that the nearest approach to absolute stability may be obtained through the application of the principles of mechanics governing force and resistance.

Hence, Newton's law, that *action and reaction are equal and opposite*, may be relatively applied to the action and reaction of force producing appliances upon the teeth, and from this principle of physics has been deduced the foundation principle in the mechanics of orthodontia, *viz.*,

that the *resistance in the anchor teeth*, or *basal resistance*, must *always be greater that the resistance at the points of delivery of the applied force.*

Stability in *anchor teeth* is the object of the application of this basic principle in physics, but as before stated, the comparatively unstable quality of the tissues in which the teeth are embedded makes it impossible to consider stability as an absolute factor in anchorage. Therefore, in the descriptions of some of the various forms of anchorage which follow, *stability* of *resistance* will be considered as *relative* only, though as near the *absolute* as the conditions will allow.

Furthermore, the *stability* of teeth used for anchorage varies with their power of resistance, which is determined by their use singly or in groups, by their size and location, the length and number of their roots, the period of development of the dental arches, as well as by the manner of application, the magnitude, and the direction of the applied force.

Thus, the whole foundation of the principles of anchorage is primarily based upon the utilization of sufficient passive and stable units of resistance in the anchor teeth to oppose and counterbalance or overcome the units of resistance in the teeth to be moved through the application of force, although this idea of anchorage has been modified to meet modern anchorage requirements in which the anchor teeth themselves take part in the tooth movement in conjunction with other teeth in the dental arches.

However, the resistance in the basal anchor teeth, including the choice of anchor teeth of larger size and more favorable location, the opposed resistance of teeth of less size and less favorable location, the re-enforcement of the resistance of basal anchor teeth, the reciprocation of resistance of basal anchor teeth on opposite sides of the dental arch, and the adjustment of resistance values to secure proper control and direction of force, must be seen to be in each case, the *accurate selection of resistance units according to the requirements*, which is the essential factor in the following definition of anchorage:

ANCHORAGE consists in the selection of adequate and properly distributed resistance units for the control and direction of force applied to the teeth for dental arch development or for lesser tooth movements.

First Molar Anchorage.—The first molar is often chosen as an anchor tooth for the basal attachment of appliances in the correction of malocclusion because of certain anatomical and mechanical features that enter into the selection of an efficient anchor tooth.

At six or seven years of age, the first permanent molar is usually in position, and, as its name implies, is the only permanent molar ready to be used as an anchor tooth.

If the relations of these teeth are incorrect with their mates in the opposite arch, it is to them that attention has to be first directed and

their relative positions corrected and retained until occlusion of enough of the permanent teeth has been established to secure the normal relationship of the arches as a whole.

Again, later in life, when the second molars have erupted, the use of the first permanent molar as an anchor tooth receives an efficient re-enforcement to its resistance to tooth movement anteriorly, from the fact of its being supported by the second molar and the strong alveolar process surrounding it.

The roots of the first molar are also more diverging than those of the second, so that the first molar has a greater comparative resistance value than the second molar because of the greater force required to displace it. The eruption of the third molar adds still greater resisting power in movement of teeth anteriorly to the first molar as an anchor tooth.

Up to this point in the description of the principles of anchorage, stress has been laid upon the *selection* of *anchorage resistance* and its distribution in the dental arches, based upon the varying degrees of resistance of the teeth themselves, and the osseous structures in which they are embedded. Anchorage resistance has been considered chiefly from its physical aspect in comparing the resistance values of the teeth themselves, according to their size and location, their periods of development, and the necessities of treatment.

A further consideration of the principles of anchorage deals with the *added resistance mechanically obtained by the method of attachment of the appliance* and the *scientific building* up of *anchorage* by *mechanical means*.

Mechanical Requirements of Anchorage.—In the mechanical building up of anchorage resistance to the application of force, the necessities of treatment must first be considered as to the degrees of resistance required in the anchorage for the *potential* and *direction* of the applied force. For example, if *inclination movement* is to be carried out, a lesser degree of anchorage resistance will be required than for *bodily movement*.

Inclination movement of the anchor teeth calls for a *pivotal attachment*, while *bodily movement* of the anchor teeth requires a rigid, *nonpivotal attachment* so that the anchor teeth may be moved bodily through the osseous structures. Again, if the force is applied in two directions to the anchor teeth, the resistance in the anchorage must be mechanically built up to sustain the stress in both of these directions.

Provision must therefore be made through the method of attachment to the anchor teeth for their *inclination* or *bodily movement* in both the *mesio-distal* or *bucco-lingual directions* according to the indications of treatment.

Thus, it will be observed that there may be a *minimum degree* of resistance built up in the anchor teeth through the use of an attachment requir-

ing *inclination movement* only, and a *maximum degree* of *resistance* built up in the anchor teeth by mechanical means through the use of an attachment requiring *bodily movement* of the anchor teeth.

Again, the *minimum degree* of resistance mechanically built up in the anchor teeth by the method of attachment should always be *sufficiently stable* for the accomplishment of the necessary tooth movements in the dental arch other than the movement of the anchor teeth themselves, as indicated by the requirements of treatment.

For example, the *minimum degree* of *resistance* in the anchorage should usually be made to be *resistance plus*, or the *maximum resistance*, by mechanical reenforcement, so that it will be sufficiently stable to offset an unknown and often powerful resistance at the points of delivery of the force. Anchor bands should be close fitting and cemented upon the anchor teeth, and anchor tubes should be attached so as to secure the maximum of resistance for use.

The attachment of the simplest appliance upon the teeth, then, requires the anchoring of the force producing appliance in such a way that the force can be continuously and effectively used to accomplish the desired tooth movements without endangering the stability of the anchor teeth to any appreciable extent.

Hence, the direction and the amount of the force exerted must be positively controlled in these attachments by a mechanically stable anchorage, the degree of stability being always proportionate to the stress of the applied force.

The Principle of Fixation.—This necessity for the comparatively stable anchorage of a force appliance in the mouth so that its force can be effectively used and controlled, both in direction and potential, has given rise to a fundamental principle relating to the stability of appliances and their attachments, which the writer has designated as the *principle of fixation*, and defined as follows:

The principle of fixation is the general condition of stability in the delivery of force for tooth movement secured by the proper gauging of resistance values in the anchorage, and at the points of delivery of the force.

The *principle of fixation* is the summing up, as it were, of all of the mechanical principles which relate to the stability of appliances for orthodontic treatment, of the quality and quantity of applied force, and of the proper proportion between the units of applied force and anchorage resistance.

The *principle of fixation* thus refers to *stability* in anchorage attachments, and in the attachments upon the teeth to be moved, and thereby to the direction and control of forces used in the development of the dental arch, or in lesser tooth movements.

A fixed appliance, then, is *one* which in its *construction*, takes *advantage* of *every applicable principle* of *mechanics* to *prevent instability* in the *delivery* of *force* for *tooth movement.*

A *fixed appliance*, as generally understood, is one which can only be removed by the operator, while a *removable* appliance can be easily removed by the patient.

In the observation and following out of the *principle* of *fixation* in the construction and attachment of appliances to the teeth, the *proper relation* between *force* and *resistance* is always obtained.

In every appliance, therefore, there must be an adequate force principle and a resistance quality in the anchorage sufficient to act as a stable base for the operation of the force. Hence, in the adherence to the *principle* of *fixation*, the various degrees of anchorage resistance are *selected*, from the *minimum* to the *maximum*, which forms the *only logical basis* for the *classification* of the various *forms* of *anchorage.*

Classification of Anchorage.—*Anchorage* may accordingly be *classified* in reference to the more definite degrees of resistance selected as follows:

1. Through the greater size, number, or favorable location, as	*Simple Anchorage*
2. By the reciprocation of anchorage resistance selected as	*Reciprocal*
3. By the addition of resistance units to an established anchorage, as	*Reinforced*
4. By the special form of the attachment used, as	*Pivotal*, and *Stationary*
5. From the source of resistance selected, as	*Intermaxillary*, *Occipital*, and *Cervical*

This classification is not essentially different from those which are already published, but these forms of anchorage will be elaborated upon in order that they may be made more clearly comprehensible. It is only to be expected that the older ideas on anchorage should change in accordance with the manner of application of force from the *biomechanical* aspect, and it must be recognized that the minimum and not the maximum degree of force is always used, and that teeth are no longer pulled, pushed, or twisted, but the dental arches are stimulated to grow by the application of the gentlest of pressure stimuli from the appliance.

The definition, description, and illustration of these classified forms of anchorage will show their special value and the reason for their consecutive sequence in the classification as follows:

Simple anchorage *is the obtaining of a sufficient resistance in one part of the arch for tooth movement in another part of the same arch, the anchorage*

resistance being relatively greater than that of the teeth to be moved, although admitting of some instability of the anchor teeth.

An illustration of *simple anchorage* is shown in the relatively greater resistance of the molar teeth in Fig. 688, as anchorage for the movement of the incisors, on account of the molars having several roots and being more favorably located between teeth of greater size, and imbedded more

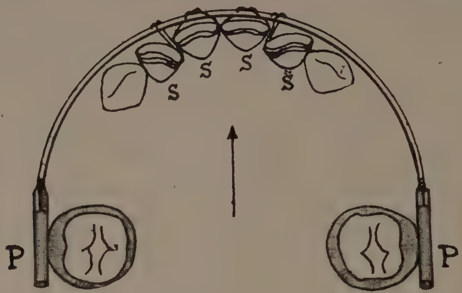


FIG. 688.—Simple anchorage with alignment arch in the mesial movement of incisors.

firmly in the bony tissues than the incisors. In *inclination movement* of the incisors, this form of simple anchorage, while allowing a slight tipping of the anchor teeth in some cases in which alternate periods of rest and renewed operation of the appliance permit the anchor teeth to settle back into their normal positions, is usually considered adequate for the purpose, but in *inclination movement* of a greater number of teeth including the cuspids, or in the *bodily movement* of the incisors, considerable re-enforcement of a *simple anchorage* is necessary.

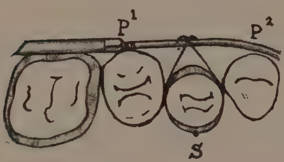


FIG. 689.—Simple anchorage with the alignment arch.

Simple anchorage is likewise observed in Fig. 689 the resistance of the molar, second bicuspid, and cuspid to the buccal movement of the first bicuspid through its attachment to the alignment arch by a ligature.

Again, in the selection of sufficient resistance for the buccal movement of the molar tooth at S, Fig. 690, the adding of the resistance of two bicuspids to the anchor tooth P by means of a lingual extension bar and ligature makes the anchorage in effect a *simple anchorage* although the adding of the resistance of one or more teeth to the resistance of any anchorage by this or other means of attachment constitutes in effect a *re-enforced anchorage* which is defined as follows:

Re-enforced anchorage *is the adding of the resistance of teeth in the same arch or opposite arch, or through the use of other forms of anchorage, as auxiliaries, in combination with the already established simple anchorage.*

Re-enforced anchorage is not a definite form of anchorage, but the term is used and defined because of the need of a general term including all of

the combinations of resistance units tending to secure a more stationary anchorage. The forms of anchorage known as *intermaxillary* and *occipital* anchorage may be used to re-enforce anchorage when they are used as auxiliaries.

If one or more teeth of equal resistance are opposed, to each other in tooth movement along the line of the arch as in the movement of the

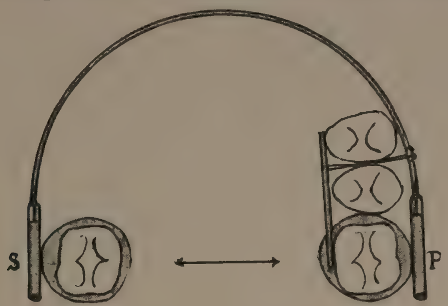


FIG. 690.—Simple anchorage with alignment arch in the buccal movement of a first molar.

two centrals together in Fig. 691 there is a reciprocation of resistance between the anchor teeth which is designated as **reciprocal anchorage,** and defined as follows:

Reciprocal anchorage *represents the counter-balancing of anchorage resistance between teeth located in different parts of the same arch, or in opposite arches, to the mutual advantage of the various tooth movements.*

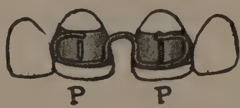


FIG. 691.—Reciprocal anchorage between two central incisors.

In lateral development of the dental arch as in Fig. 692, the molar anchorage **c** is equally antagonizing the opposite anchorage **b,** the lateral forces **f** and **a** being equally free to operate because of the similar attach-

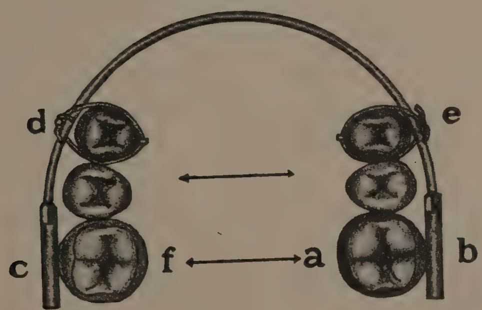


FIG. 692.—Reciprocal anchorage between lateral halves of the arch.

ments of the arch wire in round buccal tubes. If a bicuspid on each side be ligated to the alignment arch, there is simply re-enforcement of the reciprocal anchorage at **d** and **e.**

Again in the use of *intermaxillary anchorage* there is a reciprocation of anchorage between the opposing dental arches as in Fig. 708 in which the reciprocation of force and anchorage is sufficient to sustain the established anchorage of the upper first molar to distal movement.

In considering next the anchorage which are dependent upon the form of attachment used all anchorages which have attachments of a hinge-like or pivotal nature should be included. These may be designated as *pivotal anchorages* and defined as follows:

Pivotal anchorage *is that form of anchorage in which the attachments to the anchor teeth are of a hinge-like or pivotal nature.*

Pivotal Anchorage may be divided into two forms according to the plane of attachment to the teeth as follows:

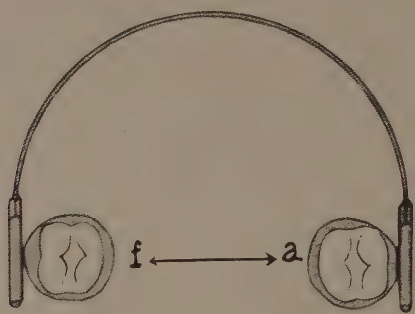


FIG. 693.—Simple horizontal pivotal anchorage.

1. *Horizontal Pivotal Anchorage* (pivotal in horizontal plane).
   (a) Simple (pivotal in one direction in horizontal plane).
   (b) Compound (pivotal in two directions in horizontal plane).
2. *Vertical pivotal anchorage* (pivotal in vertical plane).

The designations of the *subdivisions* of *pivotal anchorage* exactly describe them, which is an advantage in favor of the use of these terms, in addition to the use of some of the older terms, such as *simple anchorage*, which is a term that has lost much of its value since it represents an early form of unsupported anchorage which is not very accurate.

Further definition and description of these forms of pivotal anchorage, aided by illustrations, will serve to show the need for their special designation, as follows:

A simple horizontal pivotal anchorage is an anchorage which is *pivotal* in *one direction* only in the *horizontal plane*, as bucco-lingually or mesio-distally. An example of a *simple horizontal pivotal anchorage* may be observed in the use of *round buccal tubes* soldered to molar bands, supporting a plain alignment arch, as in Fig. 693, the force being applied buccally for development. The round buccal tubes allow of the rotation

of the alignment arch in lateral development, and a consequent slight tipping of the anchor teeth in one direction only, bucco-lingually.

A **compound horizontal pivotal anchorage** *is an anchorage which is pivotal in two directions in the horizontal plane, bucco-lingually and mesio-distally.* An illustration of this form of pivotal anchorage may be seen in the use of a *pivotal round buccal tube*, attached as in Fig. 694, so that it can pivot in either a mesio-distal or a bucco-lingual direction. This form of pivotal anchorage gives an anchor tooth the greatest freedom in its

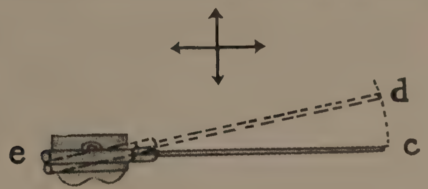


FIG. 694.—Compound horizontal pivotal anchorage.

movement when desired, as it presents the least resistance to the applied force in either the mesio-distal or the bucco-lingual direction.

Vertical pivotal anchorage *is that form of pivotal anchorage in which the anchorage attachments are pivotal only in a vertical plane, and non-pivotal in a horizontal plane, allowing of bodily movement of the anchor teeth, and their rotation upon their vertical axes.*

This form of pivotal anchorage is observed in the use of *round vertical tubes* attached to bands upon the teeth, both in the labial and lingual arches.

FIG. 695.—Vertical pivotal anchorage.

In Fig. 695 *vertical pivotal anchorage* is illustrated in the attachment of a threadless alignment arch, the round end of the arch fitting into the round buccal tube soldered vertically on the surface of the molar band. If the round vertical tube be attached in the axial center of the band on the anchor tooth, and a lateral developmental force applied, the anchor tooth will not rotate, but will move bodily in a buccal direction; if, on the other hand, the round vertical tube be attached nearer the mesial angle of the anchor band, the application of the laterally exerted force or a distally exerted force will tend to rotate the anchor tooth.

The maximum bucco-lingual and mesio-distal reenforcement of a *simple anchorage* by the use of non-pivotal attachments tends to increase the stability of the anchor teeth to such an extent that the nearest approach to absolute stability is secured, which may be designated as *stationary anchorage* and defined as follows:

Stationary anchorage *is an anchorage which is so re-enforced against pivotal tendencies in the attachments to the anchor teeth that the nearest approach to an absolutely stable anchorage is secured.*

FIG. 696.—Oval and square buccal tubes for stationary anchorage.

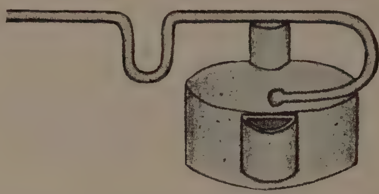


FIG. 697.—Vertical half round tube for stationary anchorage.

This form of anchorage is essentially rigid so that the anchor teeth are either absolutely stable in relation to the applied force, or are moved bodily through the alveolar process in an upright position without rotation.

The resistance, for example, in the *anchorage* must be so re-enforced mesio-distally and bucco-lingually that tipping is impossible, and this is secured by the method of attachment. Thus, in the use of the round buccal tube soldered to the anchor band in Fig. 693, the resistance to the mesio-distally applied force is essentially stable, provided the alignment arch closely fits the round buccal tube, and in effect there is a mesio-distal *stationary anchorage* established. However, if a bucco-lingual force is exerted upon this anchorage, it is only a *simple horizontal pivotal anchorage* which will allow of the tipping buccally of the anchor teeth.

In order to make this anchorage a complete *stationary anchorage* the alignment arch and buccal tube supporting it must be of the nonpivotal variety. The buccal tube may be oblong but preferably oval, while the vertical tube may be oval or half-round, in the use of which the resistance to either a mesio-distal or bucco-lingual force is unyielding, and an absolutely stable anchorage, that is, as far as mechanics can make it, is secured, provided the anchor band is well fitted and cemented in position, and the buccal tube attached as nearly as possible in the horizontal plane.

Examples of the horizontal oblong or oval tubes may be seen in Fig. 696, and in this case the ends of the alignment arch must also be of the oblong or oval form in order to fit the tubes.

The vertical half-round buccal tubes for the labial or lingual arch are illustrated in Figs. 697 and 698, the end of the .030 inch arch wire being

curved upon itself to form a lock when the engaging half-round rod is in its place in the half-round tube.

The half-round vertical tube and engaging rod is similar for the lingual arch, although the lock may be constructed of a separate and smaller gauged wire, as shown in Fig. 698.

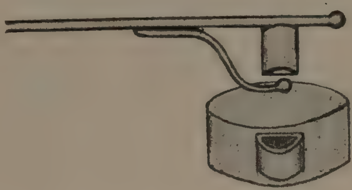


FIG. 698.—Vertical half round tube for stationary anchorage. (*Internat. Jnl. of Orthodontia.*)

In the pinched wire arch of Dr. Lourie, Fig. 685, the extremities of the arch may be soldered to the lingual surface of the molar bands in which case the anchorage is of necessity a stationary anchorage, the anchor teeth having to move bodily if at all. In this case the lingual arch is a part of the anchorage itself, as it supports the anchor teeth from mesiobuccal, and bucco-lingual displacement.

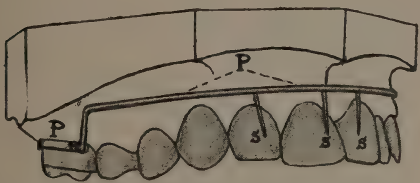


FIG. 699.—The Lourie high labial arch.

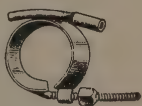


FIG. 700.—The curved sheath for Angle ribbon arch.

In the high labial arch of Dr. Lourie, Fig. 699, the arch wire also is a part of the anchorage, connecting the molar anchor teeth rigidly so that a *stationary anchorage* is affected mesio-distally, the force of the finger springs s, s, s, being exerted from the anterior part of the arch as a base.

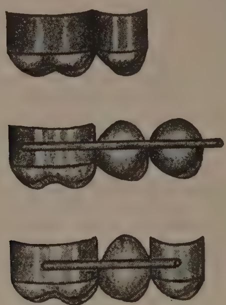
In the Angle ribbon arch, *stationary anchorage* is secured in through the curved rectangular horizontal buccal tubes, Fig. 700.

Stationary anchorage has been described in the light of an absolutely stable resistance, but as has before intimated, the stability of the most mechanically rigid anchorage is only relative on account of the elastic and unstable nature of the resistance of the vital tissues in which the teeth are embedded.

It is evident that in the effort to obtain a *stationary anchorage*, the established *simple anchorage* must be re-enforced in the principal directions in which delivered force is to be antagonized, *viz.*, bucco-lingually and antero-posteriorly.

Bucco-lingual Re-enforcement of Anchorage.—The molar anchorage used with the alignment arch may be re-enforced bucco-lingually by the use of multiple bands, by properly formed and arranged buccal tubes, by ligatures or lingual wire extensions to molar anchor bands, and by inter-maxillary force.

Multiple Band and Other Re-enforcements.—The uniting of two bands on adjoining teeth, at L in Fig. 701, will re-enforce the molar anchorage not only bucco-lingually, but mesio-distally as well. The resistance of several teeth may be secured by the use of the lingual wire extension as at M or by



L L = Multiple band re-enforcement of ahorage.

M M = Lingual wire extension for re-enforcement.

N N = Lingual bar soldered to two bands for re-enforcement.

Fig. 701.—Re-enforcement of anchorage.

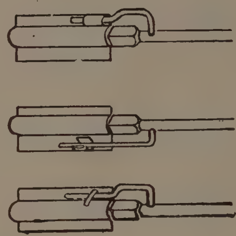


Fig. 702.—Spring arm attachments for stationary anchorage.

uniting two bands with a lingual wire as at N in the same illustration.

Form and Arrangement of Buccal Tubes for Re-enforcement of Anchorage.—Buccal tubes may be round, oval, or square, arranged horizontally or vertically, according to the needs of anchorage. In simple cases in which the molar anchor tooth is not to be moved bodily, and there is to be no bucco-lingual force exerted upon it, the round horizontal buccal tube answers the purpose. In case, however, the molar anchor tooth is to be moved bodily, or resist bucco-lingual displacement, the oval or modified square buccal tubes should be used with an expansion arch having similarly shaped ends fitting closely in the tubes. Some of the modifications of horizontal buccal tubes or spring arm attachments to the arch wire specially made to prevent bucco-lingual displacement, or for the bodily movement of the anchor teeth, are shown in Fig. 702.

Ligatures and Lingual Wires for Anchorage Re-enforcement.—The molar anchorage may be further re-enforced bucco-lingually by lingual wire extensions from the anchor bands, or by ligatures attached to plain bands upon the bicuspids.

Fig. 703 illustrates the re-enforcement of the molar anchorage bucco-lingually by the ligating of the bicuspids on both sides of the dental arch. In the use of ligatures on bicuspids it is *absolutely necessary* to band these teeth and solder on loops or spurs to prevent the ligatures

from slipping beneath the gums and injuring the peridental membrane. Much of the time spent in making bands for deciduous molars is saved by the use of the lingual wire extensions as shown in Fig. 704, an arrangement for use in the deciduous dental arch, but serving equally as well in the permanent dental arch.

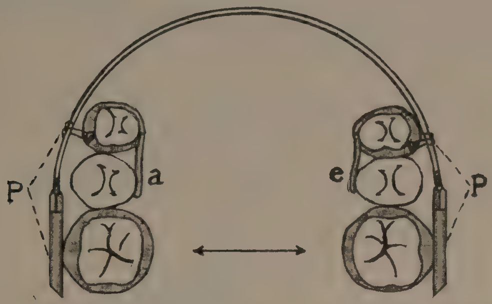


FIG. 703.—Ligatures and lingual wires for re-enforcement of anchorage.

A design of the author's for a clamp band with the lingual wire simply an extension of the lingual screw is shown in Fig. 705.

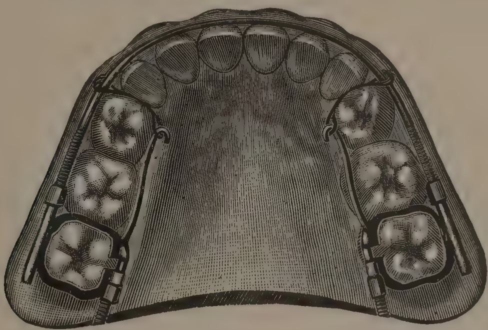


FIG. 704.—Lingual wire extensions on deciduous arch. (*Hawley.*)

The lingual wire extensions may also be used to even better advantage with the plain anchor band since it can be made to extend from the

FIG. 705.—Clamp band with lingual wire extension.

FIG. 706.—Lingual wire extension on plain anchor band.

cuspid to the second molar, as in Fig. 706, or on occasion the third molar thus securing a very greatly increased resistance to bucco-lingual displacement.

Occasionally the lingual wire extensions may be soldered to a cuspid or bicuspid band on the same side of the arch as the anchor band, or

an entire lingual arch wire extending from one anchor band to the opposite side may be used for re-enforcement of anchorage bucco-lingually.

Intermaxillary anchorage may also be used as a re-enforcement of a simple anchorage bucco-lingually as shown in Fig. 707.

Here the intermaxillary force is re-enforcing the lower molar anchorage, by operating to assist the force of the alignment arch in moving the upper molar from lingual to normal occlusion.

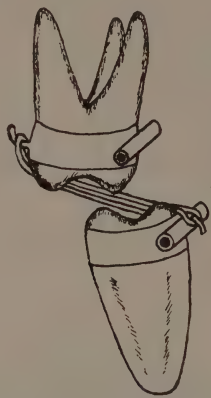


Fig. 707.—Bucco-lingual re-enforcement by intermaxillary anchorage.

Antero-posterior Re-enforcement of Anchorage.—A simple anchorage may be re-enforced antero-posteriorly by some of the same arrangements as in bucco-lingual re-enforcement, such as the horizontal and vertical oval buccal tubes, the lingual wire extensions soldered to bicuspid bands, or the use of the entire lingual arch wire attached to the anchor bands. A simple anchorage may also be re-enforced by intermaxillary anchorage which is defined as follows:

Intermaxillary anchorage may be defined as *the opposing of the resistance of the teeth in one arch against the resistance of the teeth of the other arch, partially or completely, to the advantage of tooth movement in the arch in which the lesser resistance is established.*

In reality this form of anchorage is the anchoring of intermaxillary force for its effective use in elevation of teeth, the re-enforcement of a simple or stationary anchorage, or for shifting the occlusion.

This valuable form of anchorage is applicable to all classes of malocclusion and its use is indispensable in modern orthodontic treatment.

Intermaxillary Anchorage Re-enforcement Antero-posteriorly.—It is frequently necessary to re-enforce a simple anchorage antero-posteriorly by the use of *intermaxillary anchorage.*

In Fig. 708 its use is illustrated in a Class I case in re-enforcing a simple anchorage in the lower arch by adding the resistance of the entire upper

arch CD through the medium of the intermaxillary force F; at HF is exhibited a similar re-enforcement of the upper molar anchorage H of a Class I case by adding the resistance of the lower arch EG.

In Class II the use of intermaxillary anchorage is primarily intended for shifting of the occlusion as in their arrangement in Fig. 709, but in cases complicated by deep overbite and infraversion, the attachment of

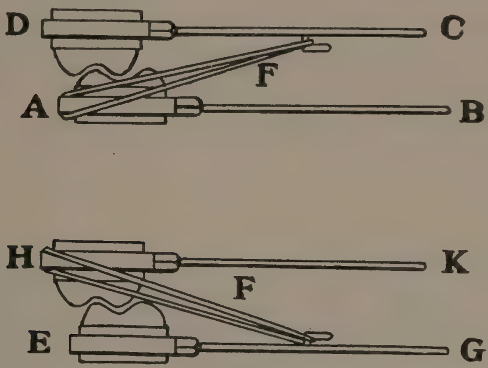


FIG. 708.—Antero-posterior re-enforcement with intermaxillary anchorage.

the intermaxillary elastics is arranged as in Fig. 710 so that the force may operate in two different directions, ED and KD, elevating the molars and shifting the occlusion at the same time.

The use of intermaxillary anchorage in tooth elevation is shown in a complex case of infraversion in Fig. 827.

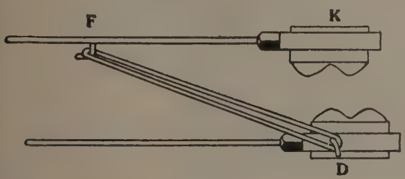


FIG. 709.—Intermaxillary anchorage in treatment of distocclusion.

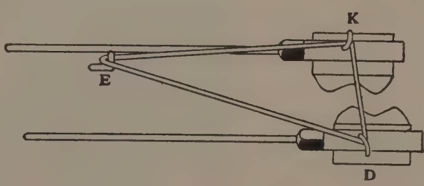


FIG. 710.—Intermaxillary anchorage in treatment of distocclusion complicated by infraversion.

Uses of Intermaxillary Anchorage.—Briefly stated, the various methods of application of intermaxillary anchorage are as follows:

The use of either arch of teeth, en phalanx, as anchorage for the attachment of the rubber ligature to effect the movement of one or more teeth in the opposite arch.

The upper arch used (en phalanx) as resistance for the consecutive mesial movement of the lower incisors, cuspids, bicuspids, and molars.

The lower arch used (en phalanx) as resistance for the consecutive mesial movement of the upper incisors, cuspids, bicuspids and molars.

The use of either arch of teeth in whole or part as anchorage for a simultaneous mesial movement of teeth in one arch and a distal movement of teeth in the other arch.

The use of the intermaxillary anchorage to sustain, or as an auxiliary to, other established anchorage.

The elevation of teeth in either arch.

The use of intermaxillary anchorage between single teeth of opposite arches, in opposing their resistance to mutual advantage in mesial or distal, and buccal or lingual movement.

The reciprocation of the movement of teeth in the use of intermaxillary anchorage, is not claimed, although it may and does occur under proper conditions, as when the anchorage resistance in one arch exactly balances that of the other.

Fig. 711.—Occipital anchorage with headgear and traction bar.

Intermaxillary force is always reciprocal; intermaxillary anchorage may be reciprocal or not, *i.e.*, the resistance in one arch may be equal to that of the other, or it may be greater or less.

Occipital Anchorage *is the use of the top and back of the head in connection with the headgear as anchorage in cases in which a powerful extraneous force is needed for antero-posterior tooth movements.*

This valuable form of anchorage has dropped somewhat into disuse, because of the splendid results which are now obtainable by the use of the intermaxillary anchorage.

The chief use of this method of anchorage is in connection with the treatment of Class II and III cases, in which the anchorage within the mouth is not sufficient to meet the requirements of the case.

Fig. 711 shows the Angle headgear and traction bar in position for the application of occipital anchorage, the socket of the traction bar engaging with the ball soldered on the front of the alignment arch.

Occipital anchorage is used in connection with *intermaxillary anchorage*, the combination of which is illustrated in Fig. 712 for the treatment of stubborn adult cases of Class II, Div. I.

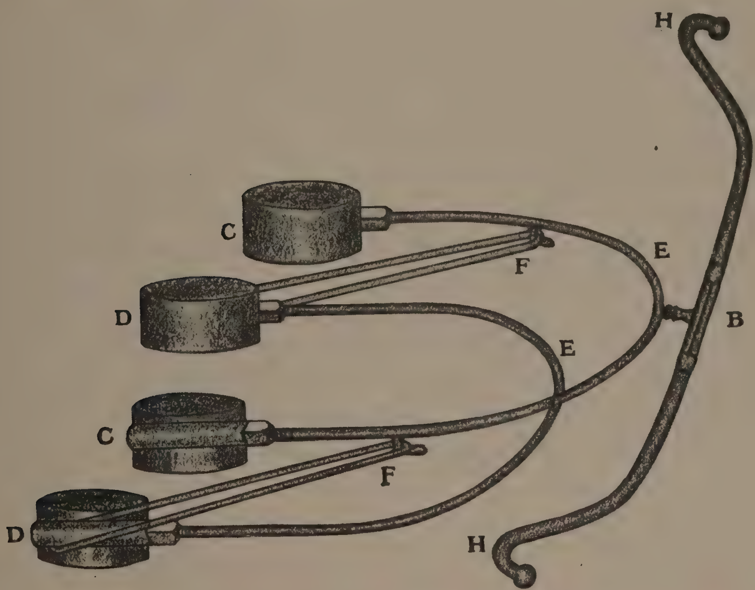


Fig. 712.—Occipital and intermaxillary anchorage.

Occipital anchorage is seldom indicated except in unusually refractory cases of Class II or III, in which it is an efficient auxiliary.

Cervical Anchorage *is the use of the back of the neck in connection with lateral bar extensions from appliances upon the teeth for anchorage.* This form of anchorage is described by Dr. Barnes in a recent monograph.

Summary of Anchorage Principles.—In summing up the subject of anchorage, the following conclusions may be made:

First, that the primary principles of force and resistance in action and reaction apply equally well in the mechanics of orthodontia in orthodontia as in other fields of applied mechanics.

Second, the subject of anchorage resolves itself into that of comparative measures of resistance, always, however, with the securing of a greater resistance at the base of attachment of an appliance than that to be overcome at the point of delivery of the force.

Third, that the applied force shall be sufficient for the required tooth movements, and under perfect control.

Fourth, that the force be applied in the most direct manner for tooth movement, but not so rapidly as to endanger its own basal anchorage attachments, or cause undue strain on the teeth and consequent pain.

Fifth, that the force producing appliance be simple and yet correct in principle for the restoration of normal occlusion.

Sixth, that the addition of re-enforced anchorage of any kind is advisable where the simple anchorage is not sufficient for the desired tooth movements.

Seventh, that advantage should be taken of reciprocal anchorage whenever possible, either in the same arch, or opposing arches, for sustaining the stability and integrity of the primary anchorage, as well as increasing the efficiency of the appliance.

Eighth, that the *principle of fixation* be observed in the stability of anchorage attachments and the direction and control of forces therefrom.

Ninth, in the use of intermaxillary anchorage, especially in connection with the primary established anchorage in both arches, the greatest attainment in the scientific application of anchorage is achieved and the most difficult results obtained in the treatment of malocclusion.

Tenth, that the appliances must be kept up to their highest standard of efficiency at all times during the progress of treatment in order to conserve anchorage and the length of time for operation.

CHAPTER XLIX

OPERATIVE TECHNIQUE

Application of Principles.—Having considered the qualifications of modern appliances for dental arch development, their various forms and special features, their control of force and utilization of anchorage resistance, their further adaptation and technical operation upon the teeth themselves will serve to show their practical use in the treatment of malocclusion. In practical operative technique, whether it be in the use of a labial or lingual alignment arch or an appliance of different principle and construction, its application to the teeth in securing correct forms of anchorage and in the direction and control of force, will be governed by the same principles of dynamics and anchorage which have been elaborated upon.

The Alignment or Expansion Arch.—Simplicity in appliance construction and efficiency in operation has evolved the modern alignment arch,

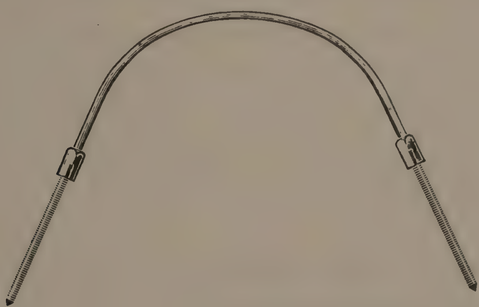


FIG. 713.—The threaded labial alignment arch.

Fig. 713, which will be found to possess certain characteristics which stamp it as one of the most superior of all appliances for the complex requirements in orthodontia. Chief among these qualities is its universality of application and efficiency of mechanism through its control of the movement of all of the teeth in both dental arches.

For whatever reason other appliances may achieve favor among orthodontists, the labial alignment or expansion arch, because of its ease of adaptability in the simpler ready made forms for immediate use, will probably always remain the most universally used and best understood appliance for the general practioner who undertakes the treatment of simple cases, who may not have the opportunity to acquire the necessary knowledge and skill in construction and operation of other forms of appliances which may be in greater favor with the orthodontic specialist.

The principal mechanical features of the labial alignment arch are its possession of the principles of the spring, the screw, and the lever, the center of the spring being in the center of the bow of the arch, which, from end to end, presents the appearance of a double jackscrew, with all the advantages of the fine gradations, yet strong and efficient force of the screw principle.

When anchored in position upon molar bands upon the teeth, it can be used as a reciprocating spring for the balancing of force and resistance from one side of the arch to the other, for lateral and anterior development of the dental arch, for correction of infra- and supra-version, and all of the malalignments of teeth within its compass, and as a base of anchorage for tooth movement in the opposite dental arch in which it is applied.

The alignment arch should be possessed of a hard temper, so as to be capable of exerting the continuous pressure of the spring for developmental purposes. It is furnished ready made in lengths according to the size of the dental arch, and of a size according to the degrees of resistance to be encountered, or in proportion to its use as re-enforcement of anchorage.

Variety in Form of the Alignment Arch.—Since the first edition of this chapter in 1908 in which the author described three different sizes of a labial alignment arch but of similar form to the one shown in Fig. 713, there have been introduced a number of valuable modifications in its size and form, adopted because of certain well-defined needs, such as variation in size from 16 to 21 gauge, or .45 to .025 of an inch, the milling of the ends to fit oval or rectangular buccal tubes, and its construction with and without threaded extremities. The change from a wire of large gauge to one of a smaller diameter is a factor in efficiency which is well worth consideration. As stated in a previous chapter, the alignment arches of smaller gauge are more capable of imparting their elasticity in the use of ligatures, and in the pin and tube and ribbon arch attachments than are the stiffer arches of 16 or 17 gauge. However, the gain in efficiency in tooth movement in the anterior portion of the dental arch in the adult mouth, is compensated for by a loss of efficiency in lateral development in the molar region with the smaller gauges of alignment arches, in which latter case there is not always sufficient lateral spring to overcome the resistance in the molar region. There is still a field of usefulness for the larger gauge arches, ranging from the youthful cases, in which considerable widening in the molar region is necessary, to the adult cases, in which the larger gauge alignment arches are advantageous for lateral development. In the high labial arch of heavy gauge wire, the arch wire itself may take part in the anchorage and serve as a base for the delivery of force to the auxiliary springs.

When alignment arches are made smaller than 17 gauge, they frequently break in the threaded portion. This has been overcome by the use of an

alignment arch of a larger standard size, 16 gauge, in the threaded extremities, having a central arc of any desirable narrower gauge, from 16 to 20 B. & S., Fig. 714.

The ends of the arch are also milled flat on two sides so that a stationary anchorage may be obtained with the use of an oval buccal tube. This style of arch has a further distinct advantage in the standardized gauge of the threaded extremities, in that at any time during treatment, a change in the size of the arch may be made without changing the supporting buccal tubes on molar bands.

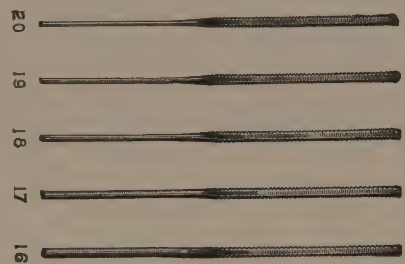


FIG. 714.—Threaded alignment arch with extremities of 16 gauge and 16 to 20 gauge anterior arc. (*Julius Aderer.*)

Adaptation of the Threaded Alignment Arch.—The threaded alignment arch should be made to conform to the general outline of the labial and buccal surfaces of the teeth at the beginning of treatment in order to be comfortable for the patient, and at the same time no portion of the alignment arch should be bent too far away from the teeth at any point for efficient attachment of ligatures.

Often it will be necessary to bend the arch wire around a certain tooth which is so far in labioversion or buccoversion that it interferes with the adaptation of the alignment arch to the rest of the teeth to too great an extent for comfort or practicability. These bends may be gradually worked out as the case progresses, and the dental arch is restored to normal size and shape.

Correction of Lines of Exerted Force in Alignment Arch.—It is evident from a study of the dynamics of the alignment arch that certain changes in the form in which it is furnished are necessary for the correction of the lines of force which it exerts at its extremities. For example, in Fig. 715, the arc AB describes the path of the force exerted by the alignment arch as it would be if it were used in the form in which it comes from the manufacturer. Applied in this form, there is the extreme of exerted force in the molar region, while in the region of the cuspids the amount of force exerted is almost nil. The molar anchor teeth, following the path of this curve, must also be rotated from their distal angles.

It is evident, that the force is incorrectly applied in this manner, and renders the work inefficient. To correct the direction of the force so as to exert force in the bicuspid region as well, the arch must be bent in a broader anterior curve as at D, Fig. 715, and, to correct the direction of force upon the molar tooth, the ends of the arch must be rather sharply bent inward in front of the nut G, so that the force will be directed more nearly along

the parallel lines, as indicated by the arrow EF. Thus, by this correction of deficient original form there is a gain in efficiency in operation of the alignment arch.

Bucco-lingual Alignment of the Anchor Tubes.—If the anchor band is one in which the buccal tube is already soldered to the band, care should

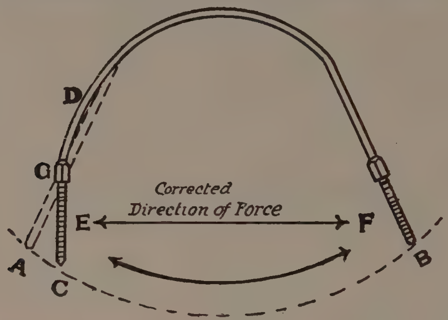


FIG. 715.—Shaping the alignment arch for correction of exerted force.

be taken in adjusting the band so that the tubes will be aligned parallel to the buccal cusps of the molar, or if adjusted to a bicuspid, parallel to the buccal surface of the bicuspid, so that the alignment arch may be easily slipped into the tubes without unequal tension at the end of the tube on either anchor band.

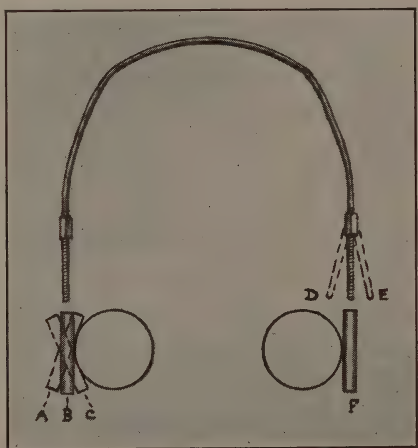


FIG. 716.—Bucco-lingual alignment of anchor tubes.

Fig. 716 illustrates diagrammatically the relationship of the alignment arch to the tubes on molar anchor bands, B and F representing the positions of anchor tubes in which the ends of the alignment arch will slip easily and uniformly into them, and A and C, positions in which the tubes are so far from the parallel that the arch cannot be readily inserted, and

which would be creative of unequal tension upon the molar to such a degree that rotation of this tooth would be inevitable, and the easy manipulation of the arch interfered with.

Where it is desired to rotate the molar on which the anchor band is placed, the end of the alignment arch may be bent lingually from a point in front of the nut as in D, Fig. 716, and the alignment arch sprung into place, causing the mesial angle of the molar to turn buccally and the distal angle lingually. A buccal bend as at E will cause the tooth to rotate in the opposite direction.

Vertical Alignment of Anchor Tubes.—Although the anchor tubes may be aligned so that they allow the arch to be readily slipped into them

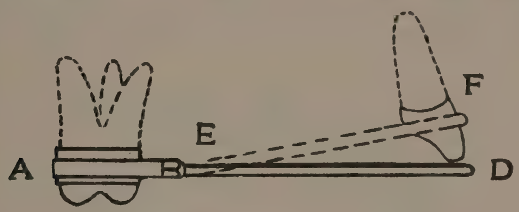


FIG. 717.—Bending of alignment arch AD to position AEF.

as just described, it will usually be found that the bow of the arch is either too high or too low on the labial surface of the incisors, often as at AED, Fig. 717, the arch resting against the incisal edges.

It is permissible in some cases in which the upward or downward inclination of the alignment arch is not excessive to bend the alignment arch in front of the nuts at E, Fig. 718, so the front of the arch will rest in its proper position, AEF, upon the labial surfaces of the incisors.

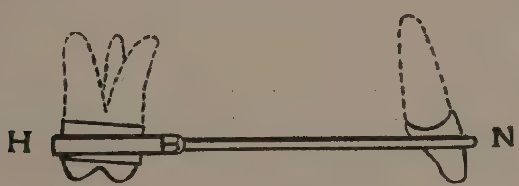


FIG. 718.—Realignment of anchor tubes on molar bands to secure proper arch alignment.

The author prefers to unsolder the anchor tubes in case of any great variation from the desired alignment, and re-align them so that the arch and anchor tubes will be in the same plane when in proper position, as at HN in Fig. 718, the force being delivered more directly, and being less liable to tip up the molar anchor tooth. The change of alignment by this method is very easily accomplished by the use of the soldering clamps as illustrated in Fig. 1076 in the chapter on constructive technic.

Anchorage with the Labial Arch.—In the use of "fixed" appliances for the correction of malocclusion, an alignment arch, of either a labial or

lingual pattern, supported by plain bands upon molar or bicuspid teeth forms the usual basal attachment in each arch of teeth for the obtaining of sufficient resistance for the tooth movements in that arch.

A combination of several of the various forms of anchorage which may be secured with the labial alignment arch in the same dental arch is shown in Fig. 719.

Simple anchorage would be here represented by the first molars in their opposition to the central or lateral incisors DE or FG which are ligated to the alignment arch, the resistance of the incisors to forward movement being less than the molars to distal movement when the nuts HH are tightened. *Reciprocal anchorage* is maintained between the bicuspids through their ligation to the alignment arch. The resistance of one bicuspid B to buccal movement is offset or counterbalanced by the ligation

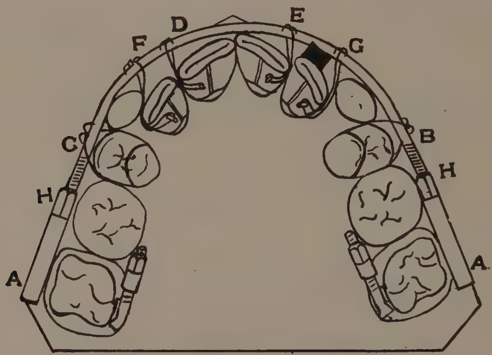


FIG. 719.—Various forms of anchorage with the alignment arch.

of its mate C on the opposite side, neither affecting to any degree the first molar anchorage, since their lines of resistance are at right angles to the established lines of resistance of the molar anchorage. The ligation of the bicuspids B and C may also be designated as *re-enforced anchorage*, since added resistance to the buccal movement of the molars is thus obtained.

The reciprocation of force between the spring of the arch and the elasticity of the rubber wedge between the left lateral which is ligated to the alignment arch at G, may also be designated as reciprocation of anchorage, although it is a secondary anchorage.

Stationary anchorage might be accurately represented in the first molar anchorage when but one or two incisors are ligated to the alignment arch at a time.

The use of intermaxillary anchorage in connection with the labial arch is called for in all classes of malocclusion, either for the direct application of intermaxillary force or for purposes of auxilary anchorage resistance.

Ligatures as Auxiliaries in Anchorage.—It will be seen that in the use of the labial alignment arch, the control of all the units of resistance of

individual teeth within the arch is obtained, and in this form of arch by the simple attachment of ligatures around the teeth and over the arch.

Often the arch is ligated to the incisors firmly, simply as a *re-enforced anchorage* for support for the arch during the movement of cuspids or bicuspids to alignment.

It is necessary in many cases, to secure the resistance of the arch as a whole, to oppose tooth movement in the opposite arch, when the resistance of every tooth in the arch may be obtained by proper ligation. This being determined, the application of the force from the alignment arch is obtained by the firmest attachment of the ligatures to the teeth.

If there should be any possibility of slipping of ligatures, or if rotation is necessary, the use of the Magill band with lugs, is a necessity, as a continued slipping off of ligatures will delay the completion of a case for months.

Fixation of the Alignment Arch.—In order to secure the greatest efficiency in the use of the alignment arch, the *principle of fixation* must be observed in every detail of its construction and application. Care should first be taken that the proper relation between the alignment arch and the buccal tubes exists. For example, force is lost and indirectly applied when the alignment arch is supported by a loose fitting buccal

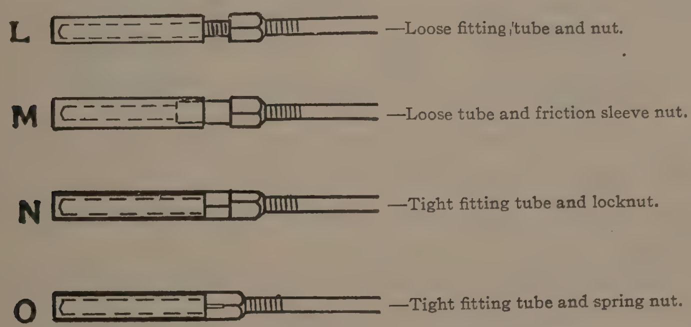


FIG. 720.—Forms of buccal tubes and nuts on alignment arch.

tube, which allows upward and downward play of the arch. Cases have been delayed for many months and have failed to be successfully treated on account of a loose fitting tube and a loose nut.

The drawing L in Fig. 720 shows a loose-fitting tube in conjunction with a plain nut on the alignment arch, a combination which is always inefficient, because of the nut being easily unturned during mastication, and because of the excessive play of the arch in the buccal tube. The Angle friction sleeve nut and loose-fitting tube shown at M, is a long step in advance, since the nut is prevented from unturning by the friction of a tight-fitting sleeve on the buccal tube. The mechanically perfect form

of the friction sleeve combination would be embodied in the additional use of the close-fitting buccal tube.

The drawing N illustrates a close-fitting buccal tube supporting the alignment arch, and the double locking nuts engaging the end of the buccal tube. This combination is rather complicated, and is but little used, although the close-fitting buccal tube eliminates all play of the arch in the tubes, and the use of the double nuts tightened against each other eliminates all possibilities of loss of force at points of delivery.

Another combination, which is simpler and takes a shorter time to adjust, is the close-fitting buccal tube and split nut shown in the drawing O. The split portion of the nut is pinched together before the nut is run on the alignment arch, so that it exerts a continual strong spring pressure upon the threads of the arch when in position, thus preventing any unturning except when the wrench is used.

Fig. 721.—Fixation of arch in buccal tubes by curved spring on extremities.

With this combination the arch is steadily supported by the close-fitting buccal tube, doing away with all upward and downward play of the arch, and the firmly set split nut keeps up the force exerted against the end of the buccal tube until the resistance anterior to the nut is overcome. In other words, the principle of efficiency has been carried out to as near perfection as is possible at this usually inefficient point.

Again, the fixation principle may be still further observed in the relation of the alignment arch to the buccal tubes by the exertion of spring force from the arch ends upon the inside walls of the buccal tubes as shown in Fig. 721.

A curved spring is ground on the ends of the alignment arch with a small carborundum wheel, taking care to first grind off the threads. This curved spring can then be bent upward to exert any desired degree of force against the inside of the buccal tube from the slightest spring force, just sufficient to gently hold the arch from slipping, to a force so strong that it is impossible to remove the arch from the buccal tubes with the fingers alone.

Forms of Anchor Bands.—The bands supporting the buccal tubes on anchor teeth are applicable in two different forms, the clamp band, Fig. 722, and the plain band, Fig. 723. The ready made clamp band, if it covers the tooth surface, and if cemented in position, fits in well with a ready made alignment arch for use by the dentist who does not understand the construction of plain bands, and who wishes to purchase a simple appliance with adaptable bands for the treatment of simple cases of

malocclusion. It possesses no other advantages, however, for it is not used by the specialist on account of the interference of the lingual screw, and its lack of adaptation to the anchor teeth by comparison with the plain band.

The clamp band with lapping ends, Fig. 722, to cover the otherwise exposed lingual surfaces of the anchor tooth, suggested by Dr. Barnes, is preferred to the style of band made without lapping ends.

A clamp band which provides a lingual screw and extension arm in one piece, for use in cases in which it is desirable to avoid ligatures

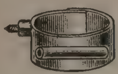


FIG. 722.—Molar clamp band with lapping ends.

FIG. 723.—Plain molar band.

upon the deciduous molars or bicuspids anterior to the anchor teeth is sometimes adapted.

Another design, Fig. 724, provides an adjustable buccal tube which, being added to an intervening torsion rod, permits of adjustment in the vertical plane through twisting of the torsion rod.

Where free pivotal action is desired as in moving molars distally, the pivotal tube clamp band, Fig. 725, designed by the author, may be used.

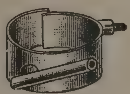


FIG. 724.—Buccal tube with torsion rod.

FIG. 725.—Pivotal buccal tube.

Separation of Anchor Teeth before Fitting Bands.—Before the adjustment of anchor bands to molar or bicuspid teeth, it is often necessary in order to avoid discomfort to the patient, or buckling of the bands in a tight proximal contact, that the teeth to be banded be first separated sufficiently from adjacent teeth to allow of the easy slipping of the edges of the bands between the interproximate contact points on either side. This is accomplished by tying silk, or twisting wire ligatures around the contact points and leaving them in position for a period of from twenty-four hours to several days.

In using the silk ligature for this purpose, a loop of No. 3 ligature silk is engaged in a loop of fine waxed floss silk, and the latter slipped between the contact points of the adjoining teeth, as in Fig. 726, and drawn through together with the heavy ligature silk as at M. The silk floss is then removed, and one free end of the ligature silk passed through the loop emerging from the interproximate space. The two free ends are next drawn taut and tied securely around the contact points as at L cutting off the surplus of silk cord close to the knot. If wire is preferred for separa-

tion, a heavy ligature wire is slipped beneath the contact points, and the two free ends brought together above and twisted as at N, Fig. 726. After cutting off the long ends the short twisted ends should be bent into the embrasure of the adjoining teeth as at O, Fig. 726, so as not to irritate the cheeks.

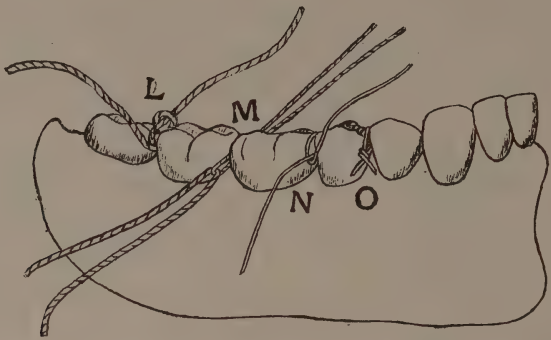


FIG. 726.—Silk and wire ligatures for separating teeth.

Adjustment of the Clamp Band.—After the adjacent contact points of the tooth to be banded have been separated sufficiently, the circumference of the clamp band is enlarged to fit loosely over the crown by unturning the nut on the lingual side, the round form of the clamp band having been previously shaped in the form of a rounded square. With the lingual

FIG. 727.—The author's band setting instrument.

screw pointing distally, where it will cause the least discomfort to the tongue, the clamp band is then forced gently to place with the thumb, or with a band setting instrument, Fig. 727, especially designed for this purpose by the author.

The surface coming into contact with the edge of a band is composed of a section of soft metal soldered to the head of the instrument, which keeps it from slipping when forcing a band or crown into place.

Being made of metal this instrument can be easily sterilized, thus possessing a distinct advantage over the wooden sticks which are often used for forcing bands and crowns upon the teeth. With this instrument

the band may be pressed uniformly into position mesially and distally by means of a slight rocking motion.

The edges of the clamp band should pass just beneath the gingiva so as to leave no surface of the tooth exposed to the possibility of caries from food retention.

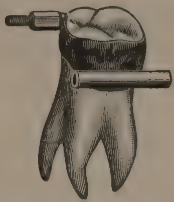


FIG. 728.—Clamp band fitted to molar crown.

When in position, the lingual nut should be tightened, and the upper edges of the band adapted to the grooves and against the inclines of the cusps of the tooth, as shown in Fig. 728. A band adapter with a serrated

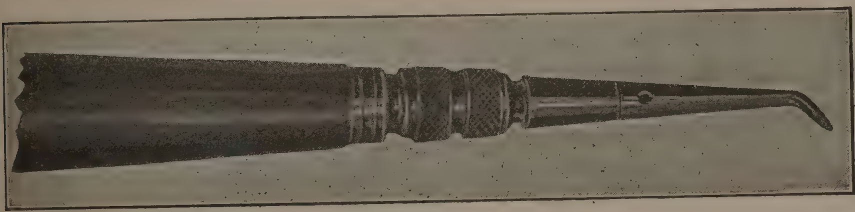


FIG. 729.—Separated tip band adapter. (*Dr. J. Lowe Young.*)

tip, Fig. 729, designed by Dr. J. Lowe Young, is a very efficient instrument for this purpose.

Alignment of Buccal Tubes.—The buccal tubes, either separate from, or already attached to the clamp band or plain band will need to be aligned

FIG. 730.—Proper adaptation of buccal tubes with nuts in embrasures.

so that they lie in parallel vertical and horizontal planes, allowing the alignment arch to rest in them with its ends parallel to each other, when the bow of the arch is in position against the labial surfaces of the incisors near their gingival borders. The tubes should also be attached as suggested by Dr. J. Lowe Young, so that the nut of the alignment arch will lie in the buccal embrasure between the anchor tooth and the tooth mesial

to it, as at A, Fig. 730, or in the next mesial embrasure, as at B, Fig. 730, in which latter case the buccal tube must be attached farther mesially.

The clamp band may be finally set in position with gutta-percha, the former material being preferable when the operation is to consume but a few weeks' time, and cement when the operation is of long duration.

Adjustment of the Plain Anchor Band.—In the use of the plain anchor band Fig. 731, special care should be observed in its fitting and contouring as upon these details depend the efficiency of the plain band for anchorage. The construction and fitting of the plain anchor band is described in the chapter on Constructive Technique. Being already fitted to the anchor tooth it is filled with cement and adjusted to the tooth with the band setter shown in Fig. 728. The anchor tooth must always be thoroughly cleaned and finally washed off with alcohol before cementing on the anchor band.

FIG. 731.—Plain anchor band.

The buccal tube should be attached as near the gingival edge of the plain band as is practicable in order to take advantage of the greater resistance of the anchor tooth at the neck than nearer the occlusal edge of the tooth.

Anchor Band Removing Plier.—In view of the possibility of injury to the gums, the anchor bands should not be removed with scalers or similarly shaped instruments. The author has designed a special plier, Fig. 732, for the purpose of removing anchor bands from the teeth, and by its use bands may be easily removed from the tenderest teeth without pain on account of the scientific adaptation of the instrument in the utilization of a powerful leverage with the occlusal surface of the anchor tooth as a fulcrum.

FIG. 732.—Author's plier for removing molar bands.

Use of Plain Bands on Anterior Teeth.—The use of plain bands on incisors, cuspids and bicuspids with the threaded alignment arch is determined somewhat by the necessities of the case. If the incisors can be controlled with silk ligatures, it may not be necessary to band them, but if not, and especially if the arch is to remain on the teeth any length of time, it is advisable to band the incisors for their protection from possible accumulation of food. If any lateral widening of the arch is anticipated,

it is necessary to band the cuspids and bicuspids. The bicuspids should never be ligated under any circumstances without banding. Soldered lingual spurs may be attached to these bands for their control with silk or wire ligatures.

Removal of Plain Bands.—The removal of plain bands from any of the anterior teeth is an operation which necessitates a great deal of care in

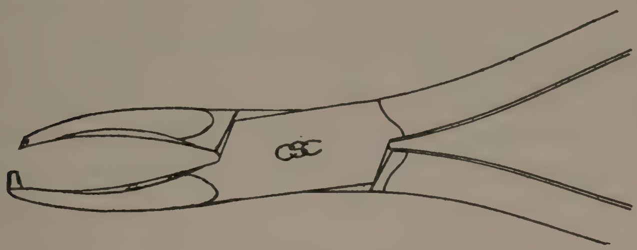


FIG. 733.—Plier for removing incisor and bicuspid bands. (*C. S. Case.*)

instrumentation because of the looseness and tenderness of the teeth in many cases, and in others because of the great force required to loosen the bands from the cement, the slipping of a scaler or other hooked instrument often used for the purpose being liable to seriously injure the tissues of the mouth. For these reasons the author recommends the use of pliers especially constructed for this delicate operation.

One of the best pliers for this purpose, designed by Dr. C. S. Case, is illustrated in Fig. 733. One of the beaks is shorter than the other and is

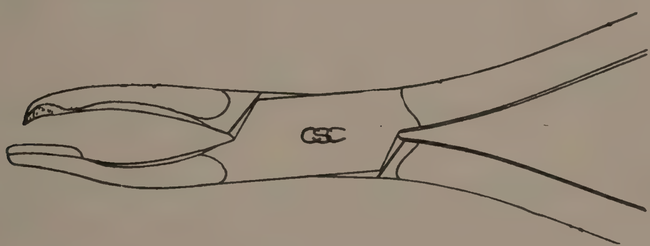


FIG. 734.—Plier for slitting plain bands. (*C. S. Case.*)

sharpened to engage with the gingival edge of a band. The longer beak is turned at right angles, ending in a tip of soft metal, which, while protecting the enamel, is of sufficient heighth and width so that it will be enclosed within the circumference of the band as it is being removed.

The force exerted by one beak to remove the band is reciprocated by the fulcrum force of the beak, so that no strain is produced upon the sensitive tissues surrounding the tooth.

Occasionally, in attempting the removal of a plain band from a tooth it will be found that the band does not readily loosen, owing to the closeness

of its fit, and the strength of the cement, in which case it is advisable to first slit the band with a plier also designed by Dr. C. S. Case, and illustrated in Fig. 734.

This band slitting plier is also provided with a soft metal cushion upon which one beak to protect the enamel, and at the end of the other beak is a hollow ground blade shaped like a plow share, the flare of which allows the edge to pass continuously beneath and through the surface of the band.

Control of the Force of the Screw in the Alignment Arch.—The most positive force in the threaded alignment arch is that of the screw, controlled by the turning or returning of the nuts in front of the anchor tubes. The turning up of the nuts may simply increase the length of the spring of the alignment arch from one buccal tube to the other as the

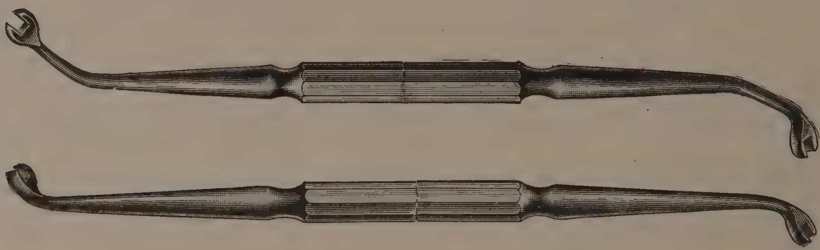


Fig. 735.—Forms of wrenches for alignment arch.

width and length of the dental arch is increased in expansion, or when the anterior teeth are ligated to the alignment arch the power of the screw exerts a direct force on the ligated teeth independent of the force of the spring, which, however, is combined with it.

As the screw is usually combined with the lever in performing work, the wrench in operative technique acts as the lever for obtaining the power of the screw.

Wrenches.—As the wrench is the most commonly used instrument for the threaded alignment arches, it should be so constructed that it will represent in material of construction, adaptation and finish, the most perfect of instruments. In the first place, it should be made of steel, which allows greater rigidity with less bulk than iron. The handle should be octagonal, giving a firm grip, and the whole instrument should be about 5½ inches long.

The socket ought not to be deeper than the width of the nut, and should fit quite accurately. The arms of the socket should be circular in form tapering down upon the handle. The wrench shown in the upper part of Fig. 735 represents the proper form of a double-ended oblique-angled wrench for use in turning the nuts on the lingual side of lower clamp bands only. The lower wrench in the same cut illustrates the straight-

angled double-ended wrench for turning the nuts on the alignment arch, one end being adapted for 12-gauge nuts, the other for 14-gauge nuts.

Ligatures.—After the proper adjustment of the alignment arch and molar bands upon the teeth, a study of the case should be made with regard to the most advantageous use of the wire ligatures, so that the most direct and positive force may be exerted upon the teeth which are to be moved, and a proper balancing of the forces obtained so that reciprocation of force may be secured from one side of the arch to the other.

Five sizes of ligature wire are in use for this purpose, their respective diameters being .013, .014, .015, .017 and .018 of an inch. For gentle traction force, the finest ligatures are most serviceable, especially in the movement of the deciduous teeth, and in the ligation of permanent teeth at the beginning of treatment when the proximation of the surfaces of the adjoining teeth render it difficult and sometimes impossible to use the heavier ligatures. The heavier ligatures are suitable for accurate and efficient work in any position where they can be used, their efficiency increasing with their diameter.

The greatest usefulness of the ligature is obtained only when the alignment arch is slightly free from contact with the teeth to be ligated, so as to secure the fullest spring of the arch wire outward where lateral development is desired.

Forms of Wire Ligatures.—The advantages to be gained by the use of a variety of styles of ligatures may be understood from a comparative study of their different methods of attachment to the arch Fig. 736, according to the desirability of the attainment of such qualities as directness and positiveness of action, freedom from pain, and inconspicuousness of appliances through the use of the least number of bands upon incisors or other teeth.

This arrangement of ligatures in Fig. 736 represents more than the actual number of ligatures that would be used in this particular case, as the use of the lingual wire extensions as far forward as the first bicuspids would materially lessen the number of ligatures as are here illustrated on one cast simply to show the different varieties.

Plain Wire Ligature.—The plain wire ligature encircling the tooth and arch, is properly used in ligating teeth which are to be moved in a straight line outward to the arch. It is improperly used on the bicuspid at A, Fig. 736, as the tendency of either wire or silk ligatures on the bicuspids is to slip toward the gingivæ, in which case they might do considerable injury to the peridental membrane. It is a safe rule to always band the bicuspids where it is not advisable to use a stirrup ligature.

The Stirrup Ligature.—To prevent possible injury to the soft tissues surrounding the teeth in ligating bicuspids, the stirrup ligature, suggested

by Dr. Lourie, and shown in position on the bicuspid, at D, Fig. 736, is most efficient, the loop extending across the sulcus of the bicuspid and soft soldered to the plain ligature at the mesial and distal angles of the lingual surface of the tooth effectually preventing any movement of the ligature toward the gingiva.

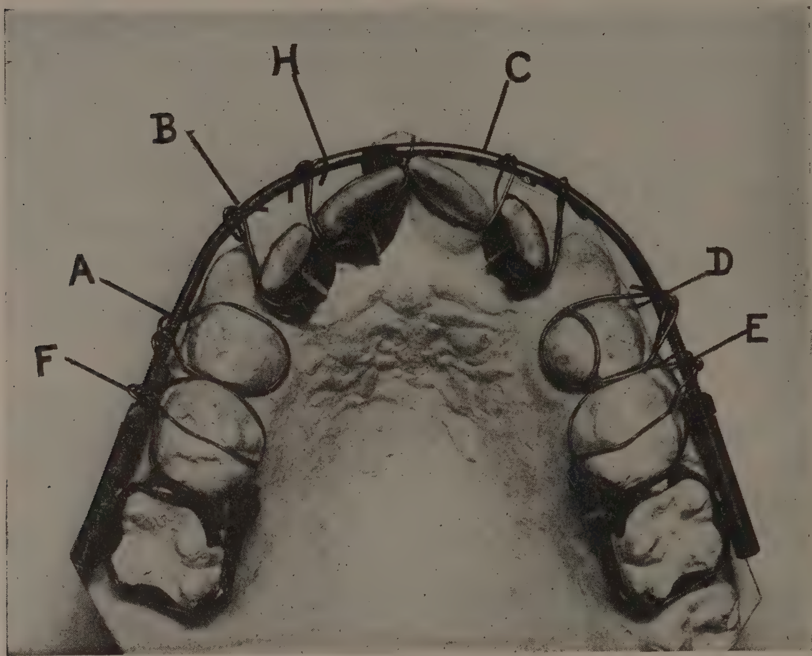


FIG. 736.—Various forms of wire ligatures.

T Ligature.—A modified form of this ligature, known as the T ligature, has been devised by the author for the prevention of the slipping of ligatures upon the deciduous teeth, the necks of which are so constricted that plain ligatures invariably tend to slip beneath the gingivæ, a class of cases in which the greatest care should be taken that there is no injury or discomfort from this cause. The T ligature is seen at F and E, Fig. 736, and is constructed by soft soldering one piece of ligature wire at right angles to another, the one ligature at right angles being carried over the occlusal surface of the tooth to engage in the twist of the other two ligature ends which pass through the interproximate spaces to the arch wire, one above and the other below.

By forming a curved hook upon the end of the wire ligatures before inserting, they will easily pass through the interproximate space without injury to the gum tissue, as the ligature will follow this curve upward or downward through the space until it reappears free from the gums on the lingual or buccal surface of the teeth.

Ligatures should be pulled taut over and under the arch wire, and pressure between the tooth and arch brought to bear with the thumb and finger, the long end of the ligature then being grasped with the left hand, and the short end with the arch and ligature pliers as shown at A in Fig. 737, and twisted to the left, always preferably twisting in the same direction. The ends of the ligatures should be clipped to one-eighth inch lengths and bent either above or below the arch to positions where they will cause no irritation, as at B, Fig. 737.

Fig. 737.—Twisting wire ligatures on alignment arch.

Arch and Ligature Pliers.—The arch and ligature pliers, Fig. 738, devised by the author, have rounded beaks except the tips, so that neither the lips nor cheek will be caught between them as in a flat-nosed plier. They are useful also for bending the alignment arch to shape as previously described.

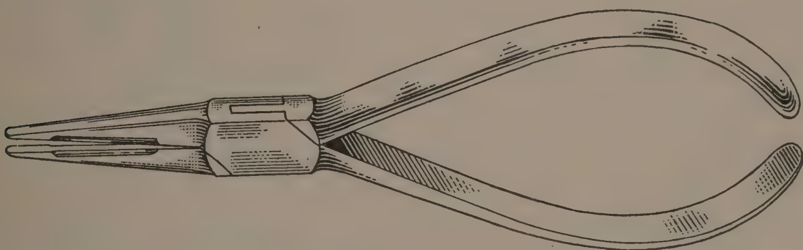


Fig. 738.—The author's arch and ligature pliers.

Removal of Wire Ligatures.—In removing wire ligatures, they should be cut from the lingual side of the teeth, and pulled out from the labial or buccal side. Otherwise, if the ligature is cut from the labial side, and pulled out, the ligature may lacerate the gum festoons, as the length of the ligature has to travel completely around the tooth in being thus removed.

Rotating Wire Ligatures.—When the direction of the tooth movement is forward and outward, especially if rotation is necessary at the same time, as in the case of the lateral incisor at B, Fig. 736, the band with lingual spur should be cemented upon the tooth, and the direction of the

ligature guided by the location of a spur on the arch wire. The rubber wedge may be placed between the arch and the nearest approaching labial angle of the tooth in stubborn cases as in the manner of rotating the central incisor at H in the same figure.

In favorable cases, the band need not be used, but the double loop ligature, shown at C, Fig. 736, suggested by Dr. Angle, will be found serviceable in rotation.

Spurs.—Again, the effectiveness of the ligature may depend upon the fixedness and location of its attachment to the alignment arch, which may be accomplished by the raised spur upon the surface of the arch wire located in such a position as to cause the movement of the teeth in a certain desired direction.

In one style of the Angle alignment arch, Fig. 739, the same purpose is accomplished by filing a notch in a re-enforced ridge which is on the buccal surface of the arch wire, this notch interfering in no way with the tensile strength of the wire since it does not penetrate its surface.

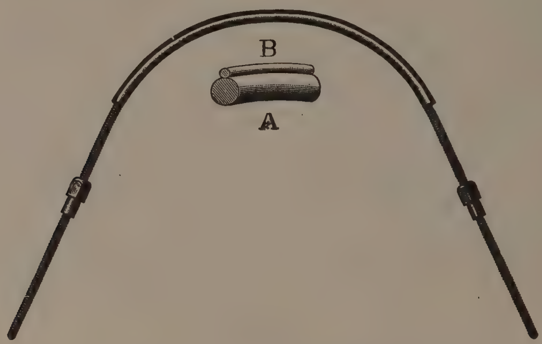


Fig. 739.—The Angle ribbed arch.

Spur Pliers.—Spurs may be easily and quickly made on the plain arch, as shown in Fig. 740, by means of the spur pliers devised by Dr. Lourie. With this instrument, applied while the arch is in position, one may seize the arch firmly between its two beaks, and by a slight pressure upon the lever at the side at the same time, a small chisel is forced against the surface of the wire at an acute angle, raising a spur which is hardly perceptible to the eye, but which is capable of holding the heaviest ligature from slipping.

When any particular barb or spur is no longer in use, it may be burnished down upon the surface of the arch wire, so as not to interfere with the lip or cheek. The spring of the arch is not in the least impaired by the spurs made in this manner.

When a longer and stronger spur is required for the alignment arch, it may be made of a piece of .30 wire soldered to the arch wire with 18-K.

solder, and the surplus wire cut off, leaving a short spur which is polished with the sandpaper disc.

An improved form of ligature cutting snips, the points of the beaks of which are long and slender, allowing of very delicate work, is illustrated in Fig. 741.

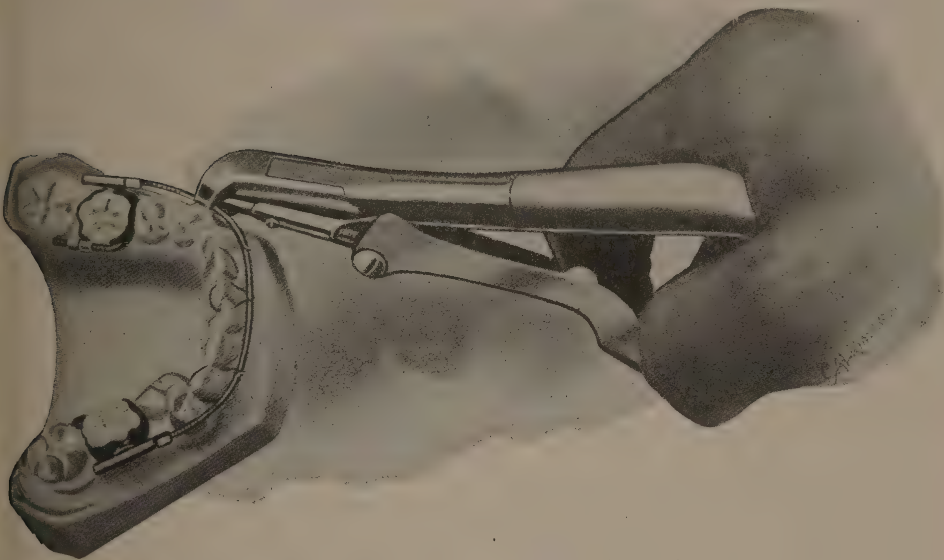


FIG. 740.—Spur cutting pliers. (*Lourie.*)

Silk Ligatures.—In view of the quicker action and greater comfort of the silk ligature for tooth movement, it has to some extent displaced the wire ligature for the ligation of incisors and cuspids. Especially is the silk ligature valuable when used for the rotation of these teeth, for the hold of the silk ligature upon the teeth is very firm and the amount

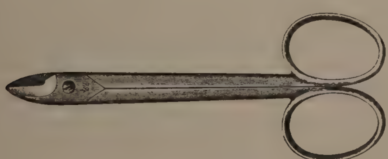


FIG. 741.—Ligature scissors.

FIG. 742.—Ligature silk.

of contraction of the silk when moistened causes the teeth to be rapidly rotated.

The silk is prepared in the form of a skein about 12 inches long, Fig. 742, and should be used in this form, as by cutting the cords at both ends of the skein, the individual silk cords can be easily be pulled out from either end. The skeins should be kept in glass tubes and saturated with campho-phenique to keep them antiseptic.

The silk ligature is useful in the hands of the skilled operator, for it may be manipulated in such a way as to avoid the use of bands to a large extent, rendering the operation less painful, and the appearance of the mouth more esthetic than when many bands and metallic ligatures are used. These silk ligatures, imported in skeins, Fig. 742, may be obtained in at least four sizes, the smaller of which is preferable for the average case.

CHAPTER L

OPERATIVE TECHNIQUE (CONT'D)
ACCOMPLISHMENT OF SPECIAL TOOTH MOVEMENTS
INCLINATION AND BODILY MOVEMENTS OF TEETH

Consideration of the Manner of Tooth Movement Desired.—In the use of appliances upon the teeth the first consideration should be the tooth movements desired and then their accomplishment in the simplest manner, using appliances which will move the teeth by *inclination* or *bodily* movement as may be indicated. Many of the tooth movements, if performed by very gradual inclination movement, will result in the normal position of the teeth in the dental arches through the stimulation of normal growth processes, and the *need* for *bodily movement of the teeth by special media of attachment will be indicated in a much smaller percentage of cases than is generally thought necessary.*

In the use of either labial or lingual alignment arches for the movement of teeth toward their normal arch positions, a number of individual and collective tooth movements are usually combined such as the movements of individual teeth along the line of the arch, the mesial or distal movements of incisors, the labial or lingual movements of incisors, the buccal movement of cuspids, bicuspids and molars, et al.

The movements of individual teeth along the line of the dental arch will be first considered.

Closing up Spaces between Incisors.—If it is desired to close up spaces between the incisors, the alignment arch is adjusted to the buccal tubes with a slight buccal spring, the nuts in front of the buccal tubes being unturned so that they do not touch the ends of the tubes and the ligatures

FIG. 743.—Closing up spaces between incisors with ligatures on alignment arch.

may be applied in the manner shown in Fig. 743, the two centrals being surrounded by a single ligature which also encloses the arch; at the same time, the laterals on either side may be similarly ligated to the centrals. The dental arch in a case exhibiting such spaces is usually overdeveloped

through tongue pressure if all of the teeth are present, and the ligation of the incisors is usually sufficient to force the incisors together and accomplish the contraction of the anterior part of the arch at the same time.

Mesial and Distal Movements of Incisors.—The mesial or distal movement of incisors is often necessary, and can be readily accomplished by the

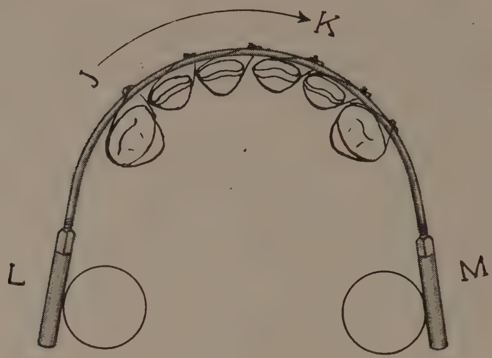


FIG. 744.—Mesial movement of anterior teeth.

use of the ligatures alone in connection with spurs upon the passively inserted alignment arch for directing the movement as desired, as in Fig. 744. The spurs are made upon the arch so as to incline the ligatures in the desired direction, mesially or distally, and the nut at L is tightened, and at M is loosened, causing the arch to shift laterally in the direction of the

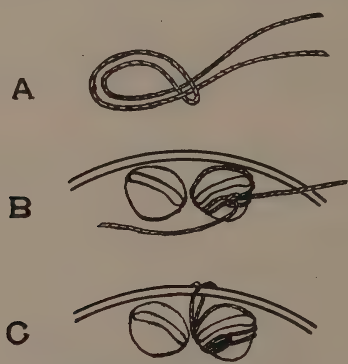


FIG. 745.—Rotation of incisors with silk ligatures.

arrow, JK, and carrying the incisors with it. The cuspids and bicuspids may be similarly ligated to the arch and share in the movement.

Rotation of Incisors and Cuspids.—The rotation of incisors and cuspids may be effected in several ways. One of the simplest and most effective is the use of rotating silk ligatures in connection with the labial alignment arch resting passively in the buccal tubes. To correctly place a

silk ligature, *e.g.*, upon an incisor, for the purpose of rotation of the tooth, the method of procedure is as follows:—First take a double strand of the silk, and doubling it upon itself, slip the two ends through the loop formed thereby, as at A, Fig. 745. Next, place this slip noose thus formed over the incisor in such a way that the noose may be tightened towards the angle of the tooth which is to be turned, as at B, Fig. 745. Separate the strands and draw them taut alternately in opposite directions. Finally pass both strands through the proximate space nearest the angle of the incisor to be labially turned, passing one strand above, the other below the alignment arch, tying them together with a surgeon's knot, as at C, Fig. 745. Cuspids may be ligated for rotation in a similar manner. Occasionally it will be found necessary to band incisors or cuspids and attach a silk ligature from a lingual spur to the arch wire in order to rotate these teeth effectively, especially in cases where the occlusion of the teeth interferes with the ligatures.

Rotation of Bicuspids.—The rotation of bicuspids may be effected in a manner similar to that of the incisors and cuspids by ligating from lingual spurs on the bicuspid bands to the alignment arch, by the use of spring levers attached to tubing on the buccal surfaces of the bicuspid bands, or by the use of auxiliary springs on a lingual arch as suggested by Dr. Mershon and illustrated in Fig. 746. The auxiliary springs for rotat-

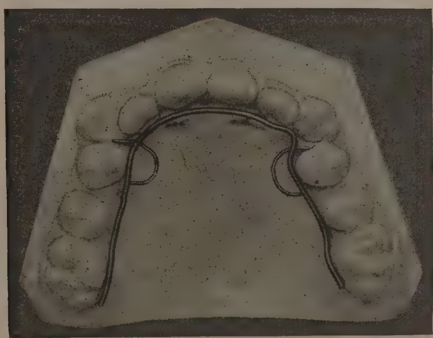


FIG. 746.—Rotating bicuspids with auxiliary springs from lingual arch. (*After Mershon.*)

ing the first bicuspids are formed in a half circle, one end being attached to the lingual arch opposite the space between the first and second bicuspids, the other free end engaging the mesio-lingual surface of each bicuspid.

One of the most successful methods of rotating bicuspids with the auxiliary springs on the lingual arch is to band the bicuspids as in Fig. 747, attaching a spur to the buccal surfaces of the bands, and with an auxiliary spring soldered to the arch some distance from the tooth to be

rotated, bend the spring almost parallel with the main arch. On the loose end of each spring some little distance from the arch, form a hook and attach a fine ligature wire engaging the spur on the bicuspid band. The ligature should be tightened until the spring is in contact with the lingual arch. The tendency of the springs to return to their original position will cause the teeth to turn on their axes.

It is always advisable to band a bicuspid and attach the silk ligature to a lingual spur to avoid the slipping of the silk ligature towards the gingivæ as happens when the ligature is applied to the unbanded tooth. Wire ligatures may be used for rotation of the anterior teeth in connection with spurs on bands in cases in which the silk ligatures cannot be effectively used.

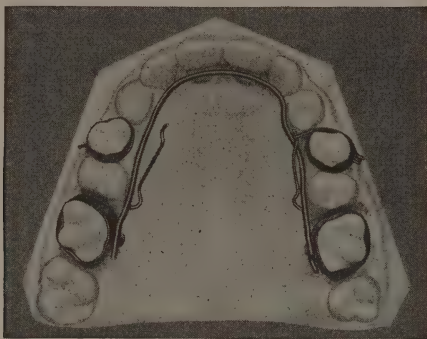


FIG. 747.—Rotating bicuspids with auxiliary springs and ligatures. (*After Mershon.*)

Labial Movement of Incisors.—One of the simplest tooth movements to accomplish because of its use of the elastic force of the alignment arch passively inserted in the buccal tubes, and the utilization of a simple anchorage, is the labial movement of the incisors in cases in which they are not inhibited in this movement by the occlusion of the teeth of the opposing arch. Fig. 748 illustrates the application of the alignment arch for this movement of the upper incisors, the arch wire being bent lingually anterior to the nuts and inserted into the buccal tubes without any lateral spring, the ends of the arch being in the same parallel planes as the buccal tubes from the horizontal and occlusal aspect. The arch wire should follow the buccal surfaces of the cuspids and bicuspids of a permanent dental arch or the deciduous molars of a mixed denture rather closely and stand away a few millimeters from the incisors as in Fig. 748. By ligating the incisors to the arch wire with either silk or wire ligatures, thus bending the wire slightly lingually, the return of the arch wire to its original form as indicated by the dotted lines will move the incisors forward towards their proper positions in the arch. By renewing the

ligatures every two weeks and occasionally tightening up the nuts in front of the buccal tubes to secure a larger anterior arc as the incisors move forward, the labial movement of the incisors is gradually accomplished. The labial movement of one or two incisors is accomplished in a similar way where there is sufficient space in the arch for their free movement.

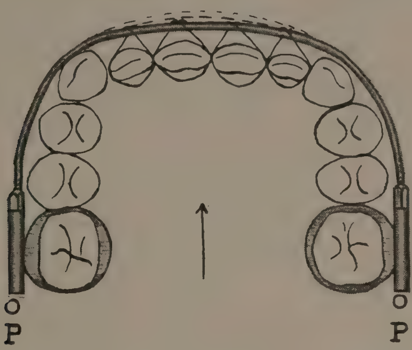


FIG. 748.—Labial movement of incisors with alignment arch.

If the upper incisors are in linguoversion, however, the simple anchorage of the first molars will have to be re-enforced by intermaxillary anchorage, by using intermaxillary force from the distal ends of the upper buccal

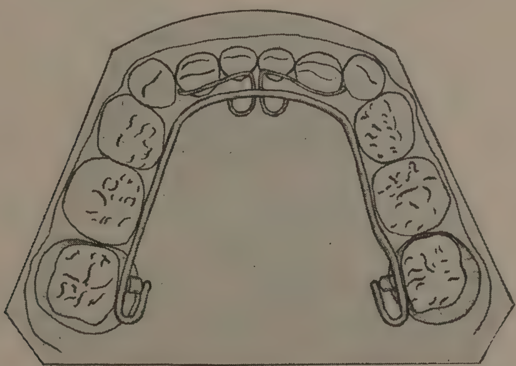


FIG. 749.—Labial movement of incisors with lingual arch.

tubes, or preferably from hooks in front of the nuts on the arch itself to hooks forward of the cuspids on a lower alignment arch, as in Fig. 841.

If the lower incisors in a given case are to be moved labially and are prevented by a deep overbite, the occlusal plane of one arch may have to be changed so as to open the bite and free the occlusion of the lower incisors before attempting their labial movement.

The labial movement of incisors may also be accomplished with any one of the lingual arches. In Fig. 749 the lingual arch, passively attached to the latch locks on the molar bands, is used as the anchorage, the labial force being exerted on the incisors through the medium of .0195 inch auxiliary springs, re-adjusted to a very gentle pressure every two or three weeks. The lingual arch is here shown in the case of a mixed denture, where its work is stimulative of normal developmental processes in the labial movement of the incisors. The lingual arch can be made more secure in cases in which there is a tendency for the patient to lift the anterior part of the appliance with the tongue by extending a wire spur lingually over the arch wire from a band on one of the incisors.

Bodily movement of the incisors is not indicated in these simple cases, as the stimulation of the growth processes aided by the function of the teeth in mastication serves to develop the apical zones so that the incisors assume their correct angles of inclination in the arch line.

Labial Movement of Incisors and Buccal Movement of Cuspids and Bicuspids.—Inasmuch as the molars do not have to be moved to effect

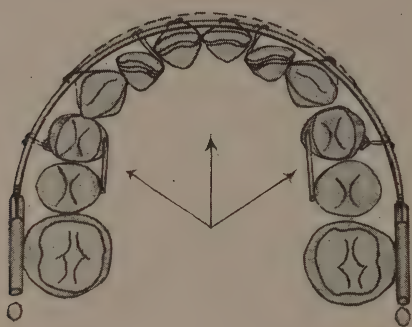


Fig. 750.—Labial movement of incisors and buccal movement of cuspids and bicuspids with the labial alignment arch.

these changes of position of the anterior teeth, the alignment arch should be placed passively in the buccal tubes without any lateral spring, the arch wires being bent in the shape of the ideal arch for the type of case being treated, so that when the labial and buccal surfaces of the incisors, cuspids and bicuspids are brought into contact with it in its final arc, they will be in their normal arch positions. Fig. 750 illustrates the position of the arch wire and the manner of ligation of the anterior teeth to secure reciprocation of force from one side of the arch to the other.

The arch wire should stand away from the anterior teeth only a few millimeters at any time, thus expending the minimum amount of developmental force through the teeth that are being moved. As the incisors, cuspids and bicuspids approach the alignment arch in its minimum arc,

the nuts in front of the buccal tubes may be tightened gradually so as to increase the arc from time to time until these teeth are all in alignment in their normal arch positions. These teeth are moved by inclination movement entirely, and yet if the case is a simple one, the stimulation to development of the dental arch produced by this gentle application of force will be sufficient so that the root positions as well as the crowns will be normally developed without inclination. The banding of the first bicuspids and the extension of a spur to the second bicuspids, ligating through a ring placed near the distal angles of the first bicuspid bands, effectively controls the buccal movement of all of the bicuspids.

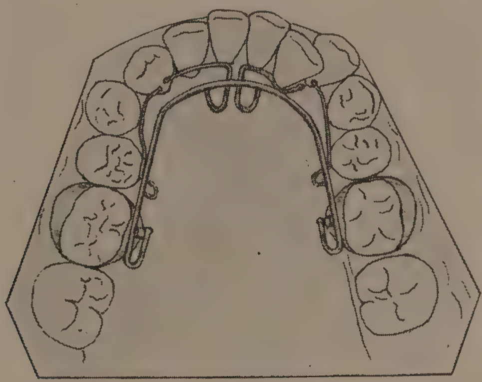


FIG. 751.—Labial movement of incisors and buccal movement of cuspids and bicuspids with lingual arch.

The use of the lingual arch in cases of this character will follow along very similar lines as far as the gentle and gradual application of force is concerned. The lingual arch with auxiliary springs in Fig. 751 is passively inserted in the lingual latch locks as no lateral force is desired upon the molar anchor teeth. The auxiliary springs are arranged so that the two anterior springs move the incisors labially and the two lateral springs move the cuspids and bicuspids buccally. The left cuspid shares in the labial movement of the incisors, and the right cuspid is indirectly moved buccally through the pressure of the right lateral incisor.

Labial Movement of Incisors and Buccal Movement of Cuspids, Bicuspids and Molars.—This combination of tooth movements is indicated in the development of the entire dental arch and may be accomplished by the use of either labial or lingual arches, utilizing either inclination or bodily movement of the teeth.

When the labial alignment arch is used with round buccal tubes for anchorage, and ligatures attached from the arch wire to the teeth for inclination movement of the teeth in the development of the arch as in Fig. 752, the alignment arch, after being properly shaped to the dental arch

and bent anterior to the nuts so as to parallel the direction of the anchor tubes, is given a buccal spring B^1 and the nuts turned up so that the arch wire stands away from all of the teeth a few millimeters. The first bicuspids are fitted with bands provided with buccal half rings for ligating to the arch wire, and with lingual wire extensions to control the second bicuspids.

The bicuspids are first ligated to the arch wire as their resistance to buccal movement is greater than that of the incisors to labial movement. The incisors and cuspids are then ligated and the increased arch tension is reflected back to the bicuspid region. Rotating silk ligatures are used where necessary.

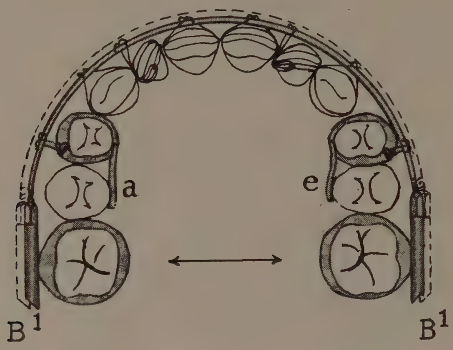


Fig. 752.—Labial movement of incisors and buccal movement of cuspids, bicuspids, and molars.

In cases where so many teeth are ligated to the arch wire, the molar anchorage should be carefully conserved and watched to prevent tipping, and if much buccal movement of the molars is needed, the anchor tubes should be of the non-pivotal variety.

After the teeth have reached the first new arc of development, indicated by the dotted line in Fig. 752, the nuts should be turned up in front of the anchor tubes so that the arch wire again stands away from the labial and buccal surfaces of the teeth a few millimeters and the teeth relegated. At no time should the maximum of buccally exerted force be used nor should the arc of the alignment arch represent in its circumference the size of the dental arch when development is complete.

If bodily movement is desired the junior pin and tube appliance may be used as in the case of the mixed denture shown in Fig. 753. In this case the pins and tubes are used on the permanent centrals and deciduous cuspids, spaces being opened for the laterals by opening labial loops in the arch wire, and the space closed between the centrals by the closing of a loop. The latch locks on the molar bands provide for the bodily buccal movement of the second deciduous molars, and, by means of the lingual

wire extensions, the first deciduous molars and first permanent molars are moved buccally.

Fig. 754 illustrates the use of the labial alignment arch for general arch development labial and buccally in a mixed denture by inclination

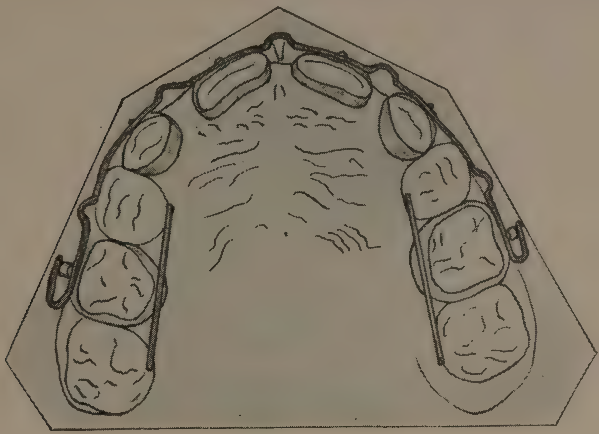


FIG. 753.—Bodily movement labially of incisors and buccally of cuspids and molars in a mixed denture with the junior pin and tube appliance.

movement. The lingual wire extensions shown in the photograph engage with hooks on the deciduous molar bands, and one ligature on

FIG. 754.—General arch development in a mixed denture with labial alignment arch.

each side from the buccal ring on each band to the arch wire controls the buccal movement of all of the teeth on each side including the deciduous cuspids.

Fig. 755 illustrates the use of the lingual arch with auxiliary springs for the labial movement of incisors and buccal movement of deciduous cuspids and molars and permanent molars in a mixed denture, utilizing inclination movement. The long auxiliary springs controlling the lateral halves of the dental arch are protected from displacement by short rods

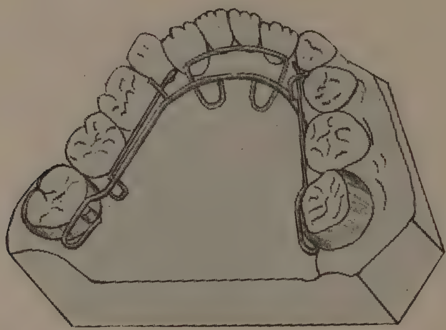


Fig. 755.—Labial movement of incisors and buccal movement of deciduous cuspids and molars with lingual arch.

soldered to the anterior part of the arch wire. The auxiliary spring for moving the incisors labially is made in one piece instead of two pieces to avoid displacement. Re-enforcement of the molar anchorage may be made by placing a band with a lingual lug engaging the arch wire on one of the incisors. The lingual arch is placed in position with a slight buccal

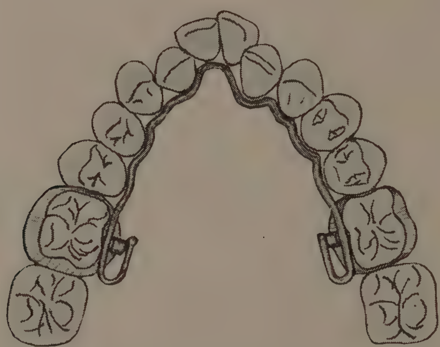


Fig. 756.—General arch development with the indented lingual arch.

spring, and increased occasionally as the development of the arch progresses. The auxiliary springs should not be increased in labial or buccal spring oftener than once in three or four weeks and then only a very slight amount to conform to the need of the gradual growth by stimulation, and in order not to tip the teeth or overcome the anchorage resistance and defeat the purpose of the appliance. If this appliance is

properly adjusted and manipulated the teeth will assume their proper arch alignment without special attachments for bodily movement.

The lingual arch without auxiliary springs fitting the indentations of the lingual surfaces of the teeth as in Fig. 756 may be used for general arch development by gradually straightening out the bends in the arch wire at intervals of several weeks. Only one bend is partially straightened at one time, and the general shape of the arch wire is retained throughout the treatment, allowing a slight lateral spring in the extremities of the wire for buccal movement of the molars. This appliance is made more positive in action by the use of spurs on one or two incisor bands to keep the arch wire from sliding upward on the inclined planes of the incisors.

The pinched wire arch of 19 gauge devised by Dr. Lourie may also be used in general arch development following the special technique necessary for the successful manipulation of this lingual arch.

Unilateral Buccal Movement of Cuspids, Bicuspids and Molars.—If the upper dental arch is in linguoversion on one lateral half it becomes necessary in the use of the threaded alignment arch to cause the buccal movement of the cuspids, bicuspids, and molars on one lateral half only

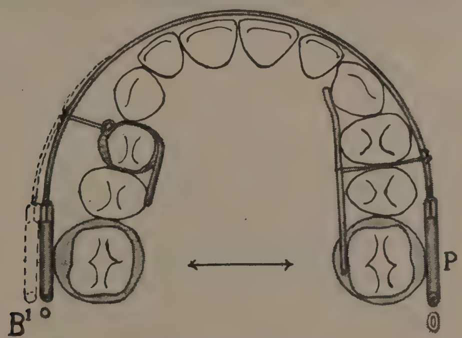


FIG. 757.—Unilateral buccal movement of cuspid, bicuspid, and molar with alignment arch.

by putting all of the resistance of the teeth in the normally related half against one tooth at a time in the half in linguoversion as shown in Fig. 757. The lingual wire extension on the molar band on the normally related half ligated to the alignment arch just distal to the cuspid secures the resistance of the cuspid, bicuspid and molar, re-enforced if necessary, by an oval buccal tube on the molar band and an oval ended arch wire; on the opposite half of the arch the molar anchor tooth is banded and provided with a round buccal tube for its pivotal action and consequent lessened resistance to buccal movement. Enough resistance is thus added on the normal side and eliminated on the side in linguoversion so that the buccal movement of the molar on the abnormal side is first effected, and consecutively, the second and first bicuspid, and cuspid.

Occasionally it will be necessary to use intermaxillary anchorage re-enforcement bucco-lingually in order to obtain the desired results without disturbing the occlusion of the teeth on the normal half.

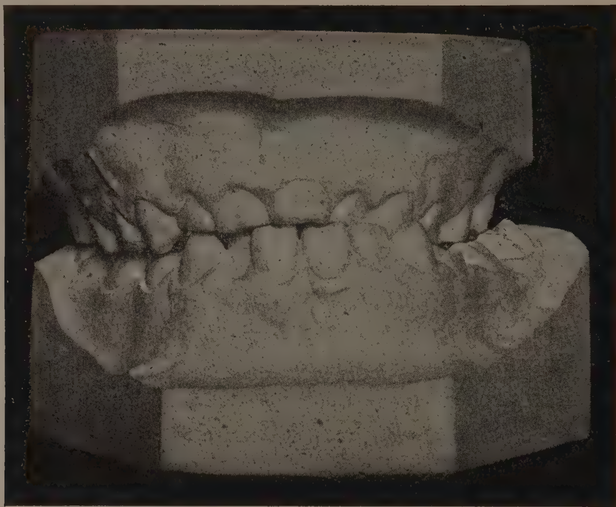


FIG. 758.—Unilateral linguoversion in a mixed denture.

Fig. 758 illustrates a case of unilateral linguoversion in the mixed denture and Fig. 759 the arrangement of the labial arch for the successive

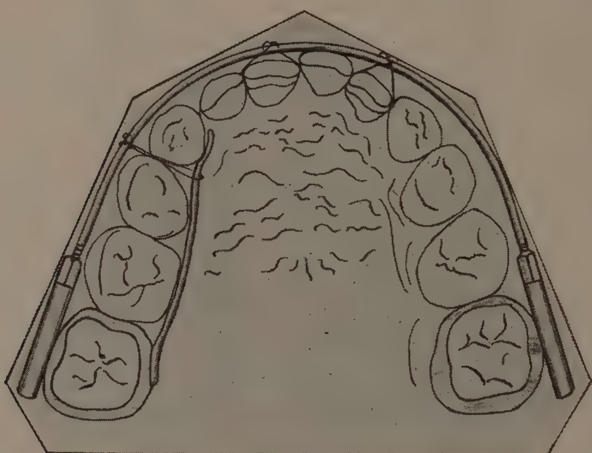


FIG. 759.—Treatment of unilateral linguoversion shown in Fig. 758 using alignment arch.

unilateral movement of the left permanent molar, second and first deciduous molar and cuspid, the deciduous teeth being successively ligated to the arch wire on the left side.

Enough resistance is thus obtained on the normally related half to move first the permanent molar and then, consecutively, by ligating to the expansion arch, the deciduous molar and cuspid into normal relations of occlusion, provided sufficient expansive force is given to the alignment arch.

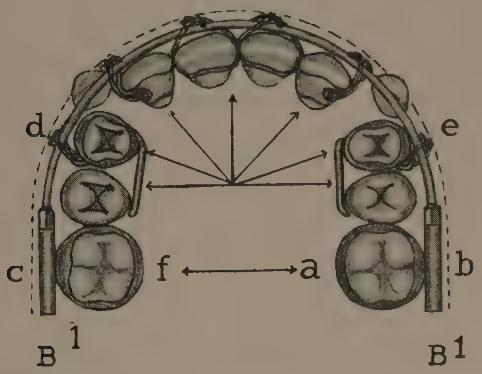


FIG. 760.—Developing dental arch and opening spaces for unerupted cuspids with alignment arch.

Opening Spaces for Unerupted Teeth.—The space for the eruption of one or more of the permanent teeth is often contracted through the movement of adjacent teeth into it, thus retarding the eruption of the tooth, and necessitating the opening of the full space to provide for its

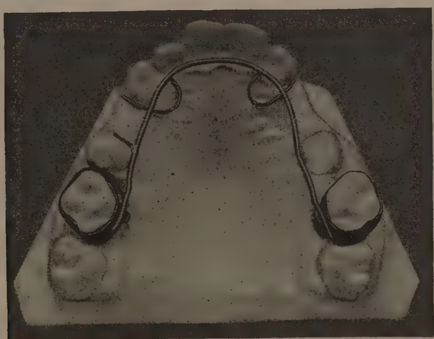


FIG. 761.—Opening spaces for missing teeth with lingual arch and auxiliary springs. (*After Mershon.*)

normal eruption. The upper cuspids are the teeth which are the most often thus retarded in their eruption and any one of the labial alignment arches or the lingual arch with auxiliary springs may be used to develop the dental arch and regain the space for the unerupted cuspids.

Fig. 760 illustrates the use of the labial alignment arch for the purpose of developing first, the size of the dental arch, and second, the spaces for the unerupted cuspids. A slight buccal force, B^1, is used to initiate lateral

development, and the bicuspids are ligated to the arch wire to take part in the buccal movement. The incisors are next ligated, and the laterals are banded, and the ligatures from spurs on their lingual surfaces engaging spurs on the arch wire tending to move the laterals mesially. Similar spurs distal to the first bicuspids on the arch will direct these teeth buccally so that as the dental arch enlarges through increase of the buccal force and increasing the arc of the alignment arch, the spaces for the cuspids gradually open to their full width and the cuspids usually erupt without further assistance into the opened spaces.

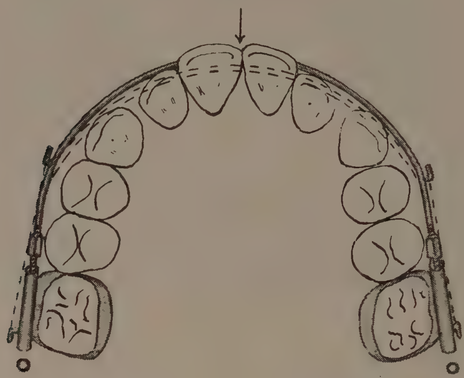


Fig. 762.—Lingual movement of incisors with labial alignment arch.

The lingual arch may be effectively used for opening spaces for missing or unerupted teeth as shown in Fig. 761. As described by Dr. Mershon, this is accomplished by the use of two auxiliary springs soldered to the lingual arch, one the width of a tooth distal to the desired space, the other the same distance mesial to the space. The one most distal curves mesially to engage the tooth distal to the space.

Lingual Movement of Incisors.—Some of the simpler cases of neutroclusion present with a protrusion of the upper incisors only, due to some lip or tongue habit. The rest of the teeth being in normal relations of occlusion, an alignment arch may be passively inserted in the buccal tubes, *i.e.* with no exertion of buccal force, the arch wire being bent to the correct form of the dental arch when restored, as in Fig. 762, and *interdental force* from rubber elastics applied from hooks as far forward as the first bicuspid or cuspid on each side to hooks near the distal ends of the buccal tubes. The nuts are unturned from the anchor tubes so that the *interdental force* will cause the arch wire to slide distally in the buccal tubes forcing the incisors lingually until they are in their correct arch positions, the dotted lines indicating the final position of the alignment arch.

The high labial arch adjusted in a similar manner with finger springs touching each of the incisors as in Fig. 699, will accomplish the same tooth movements and be less conspicuous in the mouth.

The labio-lingual arch is nicely adapted for the lingual movement of incisors as shown in Fig. 763. Being attached to the molar anchor bands by the latch lock it is in effect a lingual arch with a labial arch extension from the first bicuspids forward, and the incisors are moved lingually by contracting the loops over the cuspids. No ligatures are necessary except for rotation, a band and lug on one of the incisor teeth serving to prevent displacement of the anterior arc during mastication. The lingual arch portion of the appliance may follow the lingual surfaces of the cuspids and bicuspids standing away from the lingual surfaces of the incisors, or it may be a transpalatine arch, crossing the palatal arch in the region of the bicuspids.

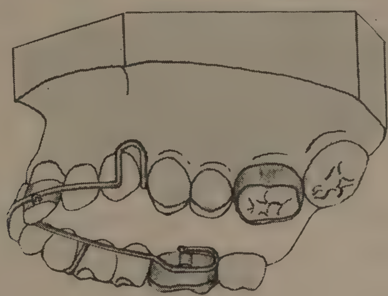


FIG. 763.—Lingual movement of incisors with labio-lingual alignment arch.

Lingual Movement of Incisors and Buccal Movement of Cuspids, Bicuspids and Molars.—In narrow upper arches with protruding incisors as in Class II, Div. I, these movements of the teeth are necessary for the establishment of normal arch form. The alignment arch, Fig. 764, is placed in the buccal tubes with slight buccal force indicated by B^1, the arch resting against the labial surfaces of the incisors. The cuspids and bicuspids are then ligated to the arch wire, leaving the incisors free from ligatures. The nuts in front of the buccal tubes are loosened a few turns, so that as the dental arch widens the alignment wire assumes a broader flatter curve, and slides back into the buccal tubes forcing the incisors lingually to a new and corrected arch form as indicated by the dotted lines. A lingual wire extension from the molar band to the first bicuspid on each side obviates the necessity of ligating the bicuspids individually. After the slight buccal force is expended in the arch wire, the lateral spring may be increased to correspond with the necessity for further buccal movement of the teeth, and the nuts in front of the buccal tubes loosened from time to time as the incisors are moved lingually and the nuts rest against the ends of the tubes.

A combination of the high labial arch with finger springs to move the incisors lingually and a lingual arch with auxiliary springs for the buccal movement of the cuspids, bicuspids and molars is also useful in producing these tooth movements as illustrated in Fig. 699.

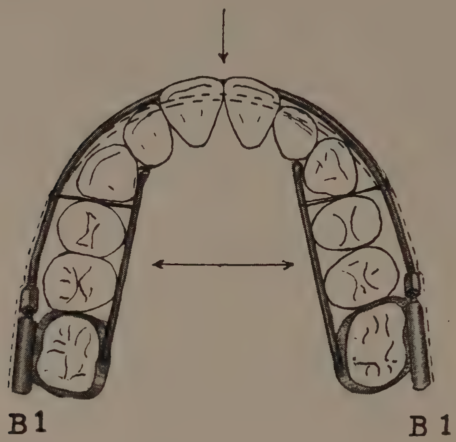


Fig. 764.—Lingual movement of incisors and buccal movement of cuspids, bicuspids, and molars with alignment arch.

Lingual Movement of Bicuspids and Molars.—Occasionally the overdevelopment bucco-lingually of one dental arch, usually the lower, will require the lingual movement of the bicuspids and molars. When the lower dental arch is overdeveloped, as in Fig. 765, the alignment arch

Fig. 765.—Lingual movement of bicuspids and molars with alignment arch.

should be adapted closely to the bicuspids, leaving a little space between the arch wire and the incisors and cuspids, and a lingually exerted force of L2 or 3, of more than slight intensity, should be applied because of the extreme resistance of the upper bicuspids and molars in linguoversion. Intermaxillary force should be applied from hooks on the lower buccal

tubes to hooks on the lingual surface of the upper first molar bands thus increasing the lingually applied force to the lower bicuspids and molars. Oval tubes should be used on the anchor bands if bodily movement of the molars is desired.

The lingual arch, Fig. 766, may be applied somewhat similarly for the lingual movement of bicuspids and molars, being inserted in the latch locks

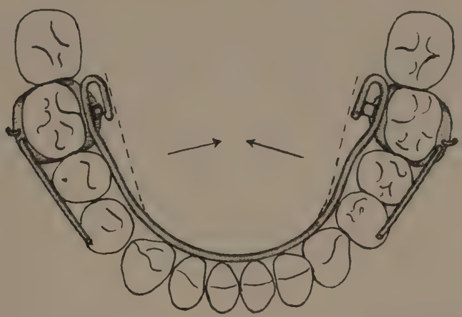


FIG. 766.—Lingual movement of bicuspids and molars with lingual arch.

with a lingual spring of L^2 or L^3. The buccal wire extensions from the molar bands to the bicuspids includes them in the lingual movement.

Rotation of Teeth with Levers.—The principle of the lever is a very old one in its application to the dental arch, but there is no doubt that its use alone as a mechanical appliance for the correction of malocclusion is a

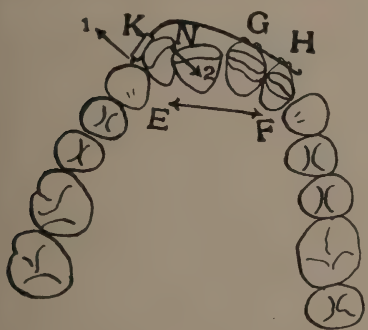


FIG. 767.—Incorrect use of lever without alignment arch.

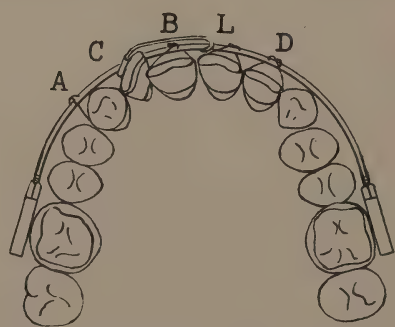


FIG. 768.—Correct use of lever with alignment arch.

misapplication of an otherwise efficient mechanical principle when properly used.

For example, in the old method of using the lever, Fig. 767, the principle of arch development to make space for a rotated tooth before attempting to turn it into position was not recognized. The fulcrum of the lever is at N, the weight at K, and the *power* at G–H. The two arrows,

1 and 2, indicate the direction of the turning tooth, and it will be seen that the arch becomes more contracted, if anything, during the process, the distance, E—F, from cuspid to cuspid remaining the same, thus preventing the alignment of the incisors, the combined mesio-distal diameters of which are greater than the arc of the arch from one cuspid to the other.

The proper use of the lever in this case should be as an auxiliary, the principal movements indicated being, first; general arch development, so that the incisors may have space for alignment; and second, rotation of individual teeth which are in torsiversion, as illustrated by the combiantion of the alignment arch and lever in Fig. 768.

By ligating the incisors and cuspids to the arch, at A, B, D, etc., the space for the lateral in torsiversion is gradually made, while the arch lever L at the same time is turning the tooth into position of correct alignment. The arch lever may be made of gold and platinum or irido-platinum, and should have a hook at one end to engage with the arch, so as to dispense with tying it.

Fig. 769.—Rotating two laterals with a single lever.

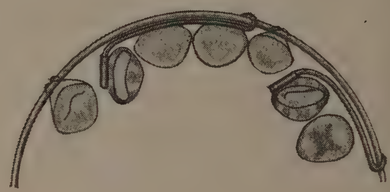


Fig. 770.—Rotation of lateral and cuspid with levers attached to alignment arch.

Fig. 769 illustrates the reciprocation of force from the opposite ends of a lever for rotating two lateral incisors in mesio-torsiversion. Fig. 770 exhibits the application of the lever for rotation of an incisor and a cuspid in the same arch.

Straightening up Molars Inclined Mesially.—In simple cases of mesial inclination of the second molars, in which the first molars have been lost and the second molars have slightly usurped the first molar spaces, through a mesial tipping, an especial adjustment of the alignment arch and anchorage is needed to effect the restoration of the second molars to upright positions.

The soldered tubes upon the anchor bands should first be so inclined and aligned that the ends of the alignment arch may be easily and passively inserted into them with no buccal spring, when the bow of the arch rests upon the gums below the incisor teeth, as in Fig. 771.

By springing the front of the arch upward upon the necks of the incisor teeth and ligating these teeth to the arch at the same time, an upward

leverage will be exerted upon the second molars which will soon restore them to an upright position.

A similar procedure should be followed in the case of the mesial tipping of the first permanent molars into the spaces of prematurely lost or extracted deciduous second molars.

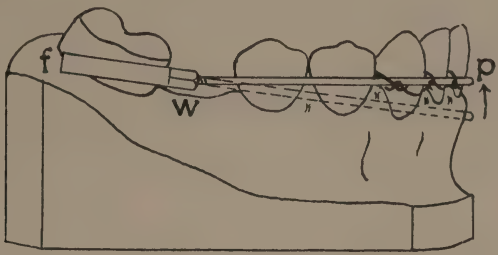


FIG. 771.—Tipping up molars inclined mesially with alignment arch.

Unilateral Straightening of Mesially Inclined Molar.—When a molar on one side only is to be tipped distally from a mesial inclination, the buccal tube for the insertion of the alignment arch on this side should be mesially inclined, while the buccal tube on the molar on the opposite side should be horizontally aligned so that when the alignment arch is

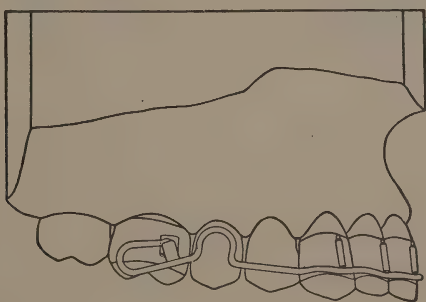


FIG. 772.—Mesial tipping of molar with pin and tube arch. (*After Young.*)

inserted into the buccal tubes and ligated to the incisors the upward spring leverage of the arch wire will tip up the mesially inclined molar. The reaction to this upward leverage on the molar inclined mesially is taken up by a slight depression of the incisors, and a tendency to tip the normally aligned molar mesially, so that no permanent displacement of the teeth other than the mesially inclined molar is effected.

The distal tipping of mesially inclined molars is effected with the pin and tube appliance as illustrated by Dr. J. Lowe Young in Fig. 772. A slight upward bend is made just anterior to the latch lock on the alignment arch so that when the male and female parts of the latch lock are united

the mesially inclined molar is tipped distally. In Fig. 773 the same writer illustrates the mesial tipping of a distally inclined tooth by the reverse relationship of the male to the female portion of the latch lock.

Mesially or distally inclined molars may be tipped in the opposite direction by the same manipulation of the latch lock of the lingual arch

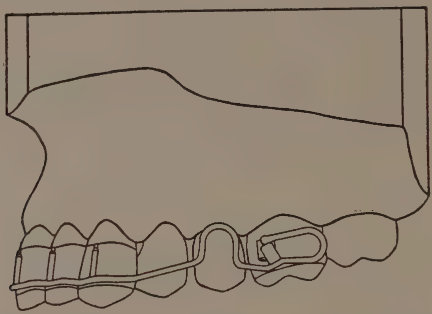


FIG. 773.—Distal tipping of mesially inclined molar by upward bend of base wire anterior to latch lock in pin and tube arch. (*After Young.*)

as shown in Fig. 774 in which the lingual arch wire has been bent upward in front of the latch lock tending to tip the molar mesially.

FIG. 774.—Mesial tipping of molar with lingual arch and latch lock.

Distal Movement of Molars.—Oftentimes it is necessary, in opening up spaces for extracted first molars, to pit the resistance of the ten anterior teeth against that of the second molars, which, in these cases, usually drift forward into the space of the lost first molars, and must be moved distally by a proper manipulation of force and anchorage.

The reversal of the base of anchorage from the molars to the anterior teeth for the distal movement of the molars, may be effected by ligating a sufficient number of the anterior teeth to the arch so that their combined resistance will be greater than that of the molars to be moved distally.

The combined resistance of the ten anterior teeth, as secured through ligation to the alignment arch as at **a, b, c, d, e, f, g,** and **h** in Fig. 775, is greater than that of the second molars to distal movement, and turning up the nuts in front of the anchor tubes will force the molars distally and regain the spaces of the lost first molars, provided the molar anchorage is made as nearly a *pivotal anchorage* as possible. The resistance to distal movement of the molars is thus very much lessened by the use of the

pivotal tube anchor band, Fig. 725. To prevent the ligatures from slipping upon the alignment arch in the region of the bicuspids, spurs should be soldered upon the arch and the ligatures attached in front of them as at **a** and **b,** thus securing the positive resistance of the second bicuspids. The proximate contact of the second with the first bicuspids will suffice to obtain the resistance of these teeth in line with the required movements although bands and spurs may be used on them to attach ligatures. The arrows indicate the direction of tooth movement, in the region of least resistance, or the distal movement of the second molar teeth.

Hooks may be attached to the alignment arch for the use of *intermaxillary anchorage*, extending the elastic rubbers from hooks on the

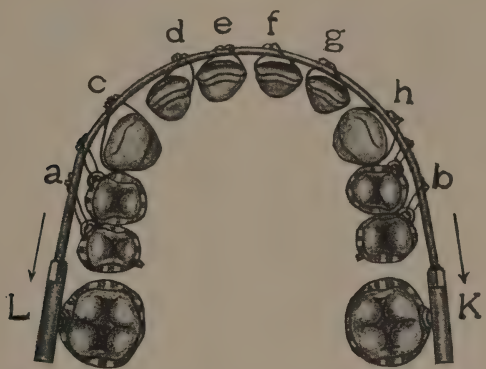


FIG. 775.—Distal movement of molars with alignment arch.

lower alignment arch to the distal ends of the anchor tubes of the upper alignment arch, in case the resistance of the single molars should prove to be greater than that of the ten anterior teeth, thus preventing misdirected movement.

As there may often be found in these cases some distal positions of the anterior teeth as a whole, having traveled distally towards the space of the lost molars, it may be found necessary to use the second molars as simple anchorage at first, using a soldered buccal tube on the molar band, and successively move the anterior teeth forward, ligating and moving two centrals, then the two laterals, the cuspids next, and so on, turning up the nuts, in front of the anchor tubes and later reversing the anchorage to the anterior teeth for the distal movement of the molars as soon as the necessary anterior movement of the incisors and cuspids is complete.

Rotation of the Mesio-buccal Angle of a Molar Lingually.—Several methods are in use for the rotation of molars in torsiversion. In the rotation of a molar which has its mesio-buccal cusp turned farther buccally than the disto-buccal cusp, the alignment arch, bent as at E in Fig.

716 before slipping into the buccal tube on the clamp band encircling the molar, answers the purpose, especially as the desired change of position of the molar is in line with the buccal movement of the alignment arch, the distal end traveling farther buccally than a point on the arch opposite the mesio-buccal cusp of the molar.

Rotation of the Mesio-buccal Angle of a Molar Buccally.—The reverse of this position, or the molar with the mesio-buccal cusp farther lingual than the disto-buccal cusp, is not so amenable to change in the desired direction by the lingual bending of the ends of the alignment arch, since

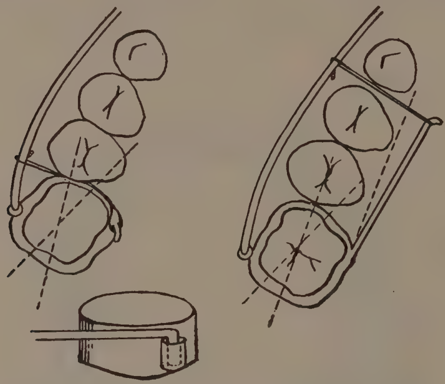


Fig. 776.—Rotation of mesio-buccal angle of molar buccally. (*After McCoy.*)

the tendency of the arch in its outward movement is to move the disto-buccal cusp farther buccally in relation to the mesial cusp, in spite of the lingual bending of the arch to prevent it. If this method of rotation of the molar is attempted, the arch should be ligated to the anterior teeth or held in place by a rubber elastic from the end of the buccal tube to a hook on the arch wire.

In cases of extensive rotation of the mesio-buccal angle of a molar buccally, a round vertical tube is soldered to the distal angle of the molar band, and a threadless alignment arch with a right angled end fitting the round vertical tube is used buccally. A ligature is then attached from a lingual hook on the molar band to the lingually bent alignment arch as illustrated in the left drawing in Fig. 776, a suggestion of Dr. James D. McCoy.* Another method described by the same author is illustrated in the right drawing Fig. 776. In this case the spring lever of .030 inch diameter soldered to the lingual surface of the molar band near the gingival margin, bent lingually about one quarter of an inch and ending opposite the cuspid in a hook ligated through to the alignment arch, will rotate the molar in the same direction. A renewal of the lingual spring of the lever and of the ligature is occasionally necessary during the treatment.

* Applied Orthodontia, by James D. McCoy, Lea & Febiger, publishers.

Molars may be rotated with the latch lock on a labial pin and tube arch as suggested by Dr. J. Lowe Young by placing a sharp bend in the arch wire just anterior to the male portion of the latch back as shown in Fig. 777. The bend on the left side A will move the mesial angle of the molar buccally, while the bend on the right side B will move the distal angle of the molar buccally. The latch lock may be manipulated in a very

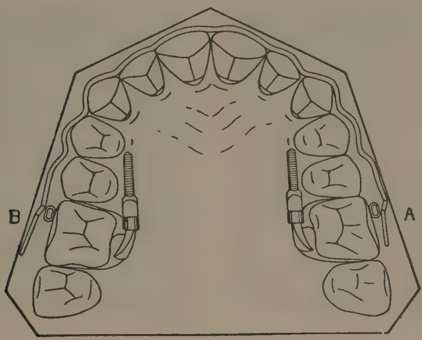


FIG. 777.—Rotation of molars by bending of arch anterior to latch lock in pin and tube arch. (*After Young.*)

similar manner for the rotation of molars when the lingual arch is used.

A lingual lock described by Dr. Ernest Bach and illustrated in Fig. 778, on account of its use of a round vertical tube for the lock aided by a locking spring wire, renders the rotation of the molar anchor teeth very simple with a lingual arch. This lock can be so constructed that different axes of rotation may be chosen as it is not always desirable to use the same axis of

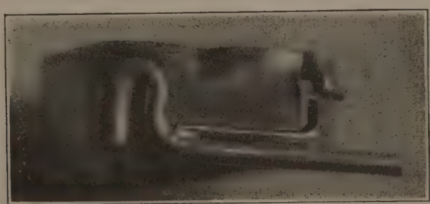


FIG. 778.—Rotation of molar with lingual arch. (*After Bach.*)

rotation. For example, the mesio-buccal cusp of the upper first molar may be lingually inclined, and the distolingual cusp in nearly its normal relation with the lower molar. Rotated molars of this class indicate that the mesio-buccal cusp be directed buccally, with the disto-lingual cusp is used as a pivoting point. Another type of rotated molar is the one which requires the mesio-buccal cusp to be directed buccally and the disto-lingual cusp lingually, the whole tooth being rotated using the center of the crown as the axis of rotation."* Figs. 779 and 780 illustrate both of these

* An Efficient Lingual Lock, by Dr. Ernest N. Bach. Int. Journal of Orthodontia, Sept. 1922.

types of molars, the molar on the left of Fig. 779 having the center of the crown as the vertical axis of rotation, the molar on the right having the disto-lingual cusp as the center of rotation. Dr. Bach here describes the technique:—

"To rotate the molar on the left, the arch wire is bent so that the pin lies anterior to the tube about the distance of its own thickness and

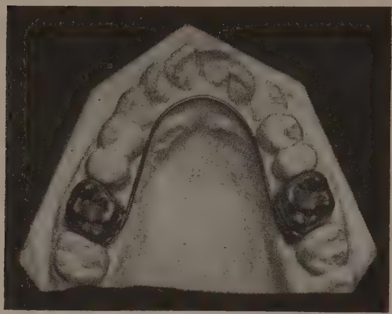


Fig. 779.—Before rotating molars with the Bach lock using different axes of rotation.

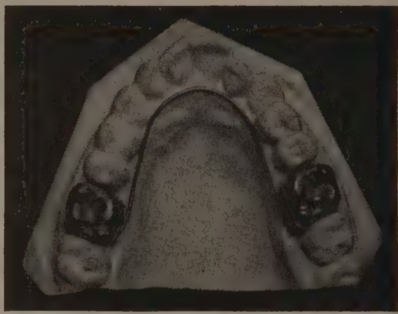


Fig. 780.—After rotation of molars with the Bach lock.

approximately the same distance lingually, while a buccal "kick" of about 1 mm. is put into the locking spring wire, Fig. 779, left side, shows the effect of the adjustment on the molar."

"To rotate the molar on the right of Fig. 780, the tube is used as the center of rotation, and the pin and tube relation not disturbed, only a buccal "kick" of about 1 mm. being put into the locking spring wire, the pin lying in the tube passively. The molar on the right in Fig. 780 shows the effect of the adjustment.

In this method, in which the attachments are all made to the alignment arch, the reciprocation of force is almost absolute from the mesio-buccal angle of the molar to the disto-lingual angle, in the rotary force exerted by the two opposite acting forces on each side.

Extrusion of the Cuspid.—In the extrusion of the cuspid, the plain band should be formed high up on the labial surface of the tooth, soldered

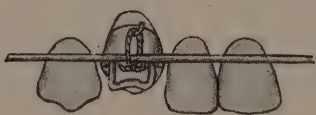


Fig. 781.—Extension of cuspid by ligating to alignment arch.

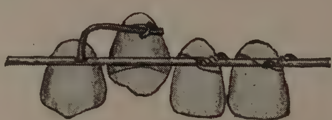


Fig. 782.—Extension of cuspid by auxiliary spring.

on the lingual surface, and a hook soldered near the labio-gingival margin of the band for the attachment of a ligature to the arch as in Fig. 781. By ligating the hook on the cuspid band to the alignment arch with either silk or wire the spring of the arch wires will extrude the cuspid until the

hook touches the arch wire. An indented loop of .025 inch wire is soldered on the under side of the alignment arch and a ligature attached from the indented portion to the hook on the cuspid band which will extrude the cuspid the remainder of the distance necessary for its arch alignment. An auxiliary spring attached to the alignment arch and engaging the hook on the cuspid band as in Fig. 782 will extrude the cuspid in an equally efficient manner. The same methods may be used for intruding teeth along the line of the arch by reversing the direction of the applied force.

Extruding Bicuspids with Auxiliary Spring.—Occasionally it is necessary to use an auxiliary spring in connection with the alignment arch to perform certain special tooth movements. An example of this kind is

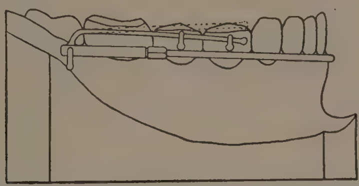


FIG. 783.—Extruding bicuspids with auxiliary spring. (*Young.*)

seen in the auxiliary spring, Fig. 783, for extruding the bicuspids, a method described and illustrated by Dr. J. Lowe Young. The auxiliary spring is soldered near the distal end of the buccal tube on the anchor band, extending forward and obliquely upward so that it can be sprung down and ligated to spurs on bicuspid bands or caught under hooks soldered to these bands. The alignment arch is firmly ligated to the incisors so as to re-enforce the molar anchorage.

Extrusion of Anterior Teeth.—The extrusion of certain of the anterior teeth in a case of infraversion, or "open bite" as it is familiarly known,

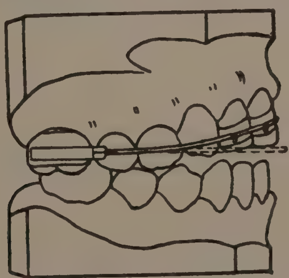


FIG. 784.—Extruding anterior teeth with the alignment arch.

requires a very careful technique based upon the extent of the infraversion of the anterior teeth distally, and consequently upon the number of teeth to be extruded to the normal occlusal plane. The most common form of infraversion presenting in practice is that in which there is lack of occlusion of the anterior teeth, varying in degree from a slight infraversion of one

or more incisors to those cases in which the upper and lower incisors are more than half an inch apart when the molars are occluding.

The simpler cases of infraversion of the incisors may be easily managed by bending the alignment arch downward before placing it in position, as indicated by the dotted lines in Fig. 784, and then springing it upward to engage the incisors when it is in position. The incisors may be banded, with labial spurs for more direct application of the force.

Extrusion of Anterior Teeth and Correction of Occlusal Plane.—In cases of infraversion of the anterior teeth with an increasing divergence of the occlusal plane from the first molars to the central incisors it is necessary to directly move occlusally most of the teeth included in the arc of the infraversion except perhaps the last distal teeth which may be in slight infraversion, but which will come into occlusion through the stress of the force applied to the teeth anterior to them in infraversion. In these extreme cases of infraversion most of the upper and lower teeth should be fitted with bands and spurs as in Fig. 785 to engage the align-

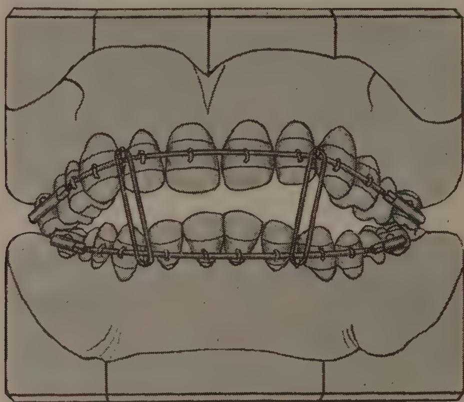


FIG. 785.—Treatment of infraversion with increasing divergence of occlusal plane from first molars forward.

ment arches which are passively inserted into the buccal tubes unless buccal or lingual movements of the bicuspids or molars are necessary. In fact, the restoration of normal arch size and form should usually be made before any attempt at correction of the occlusal plane.

The anchor tubes may be provided with swivel attachments so that the total maximum force of the intermaxillary elastics attached from one alignment arch to the other will be available without overcoming the added resistance of the molars to mesial tipping when the horizontal buccal tubes are soldered directly to the molar bands. Further description of the treatment of actual cases of infraversion will be found under the treatment of Class I (neutrocclusion) cases.

Intrusion or Depression of Incisors.—In many cases of malocclusion in which there is an apparent supraversion of the incisors, the attempted depression of the incisors without the extrusion or elevation of the bicuspids and molars is not considered practical, as the infraversion in the latter region is usually the chief cause of the apparent supraversion of the incisors. However, in the mixed denture in which supraversion of the incisors, especially the lower, is apparent, their depression may aid in changing a deep overbite, and facilitate other developmental changes in occlusion which they are preventing.

In these cases the lingual arch with auxiliary springs extending over the incisal edges has proven of value in the depression of the incisors as illustrated in Fig. 786 in a case of a mixed denture. Owing to possible

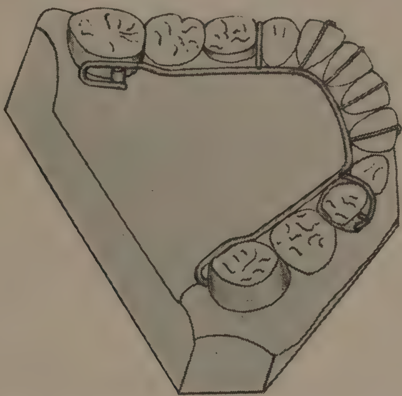


FIG. 786.—Intrusion of incisors with auxiliary springs from the lingual arch.

interference with occlusion to a slight extent the auxiliary spring wires extending over the incisal edges are very apt to become displaced, and a guard wire, crossing lingually behind them about half the height of the lingual surfaces of the incisors and bent downward at right angles in the region of the cuspids where it is soldered to the lingual arch, will assist in maintaining the delicate spring wires in position. The deciduous first molars in Fig. 786 are banded and provided with buccal spurs to engage an arm from the lingual arch for anchorage reenforcement when it is possible to use it.

In some of the more severe types of deep overbite, either in Class I or II, it is necessary to resort to more positive means of correcting the occlusal planes through the use of bite planes of vulcanite or metal in connection with intermaxillary force which will be presently described, or the use of the alignment arch on one of the dental arches for extruding the bicuspids and intruding the incisors.

Extruding Bicuspids and Intruding Incisors.—In many cases of deep overbite of the incisors it is necessary to extrude the bicuspids and intrude

the incisors in order to establish the correct occlusal plane. Fig. 787 illustrates the method suggested by Dr. C. S. Case, of using a light alignment arch as a double elastic lever, passing under hooks on bicuspid bands and over hooks on incisor bands, the turning up of the nuts on the alignment arch allowing for lengthening the arch at the same time. The buccal tubes may be provided with pivotal attachments if desired to lessen the resistance of the molar anchor teeth to mesial tipping. Also, the latch lock and loop may be used enabling the operator to remove the arch in the vertical plane.

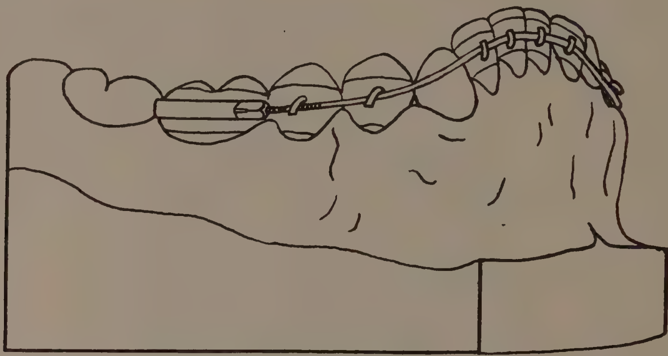


Fig. 787.—Correcting lock of vertical development with alignment arch by extruding bicuspids and intruding incisors.

Mesial Movement of Lower Teeth in Relation to Upper Teeth. Restoration of Arch Forms and Sizes. Restoration of Occlusal Planes.—These movements of the lower teeth are confined to cases of Class II (distoclusion) in which the lower dental arch is distal to the upper arch, and in which the appliances must be so arranged that the proper forms and sizes of the dental arches, especially the upper, are first established before the teeth of the lower dental arch are moved forward into their normal mesiodistal relationship. The former is accomplished as previously described, special tooth movements in the upper requiring the lingual movement of the incisors in Class II, Div. 1, and the labial movements of some of the incisors in Class II, Div. 2, combined with the development of the normal forms and sizes of the lower arch and the correction of the occlusal plane when necessary. Inasmuch as the operative technique of this class of cases is fully described under the treatment of Class II, only the more important changes in the occlusion will be dwelt upon under the above heading.

Any one of the labial arches may be used on the upper dental arch, but preferably a lingual arch is used on the lower. If, however, a labial arch has been used on the lower to restore arch form and size in the simple case, a lingual arch should be substituted as early as possible for the sake of inconspicuousness and prophylaxis. The mesial movement of the

lower teeth is illustrated in Fig. 788 in a case of Class II, Div. 1 in which the labial alignment arches are applied for restoration of arch form and size during which the intermaxillary elastics are worn from hooks opposite the cuspids on the upper alignment arch to the distal ends of the buccal tubes on the lower anchor teeth, stationary anchorage being secured in

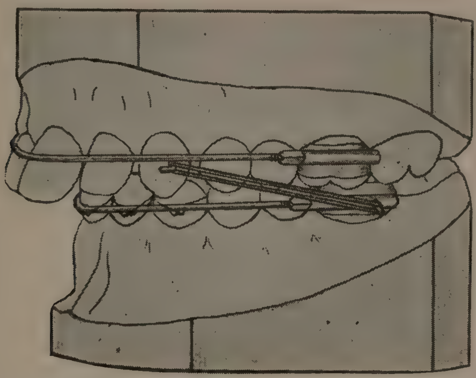


Fig. 788.—Mesial movement of lower teeth in relation to upper.

the upper arch. The removable lingual arch shown in Fig. 789 is substituted for the labial alignment arch as soon as the form and size of the lower arch is established, although the lingual arch with auxiliary springs may be used from the beginning of treatment in favorable cases. The intermaxillary elastics are attached from the hooks on the upper align-

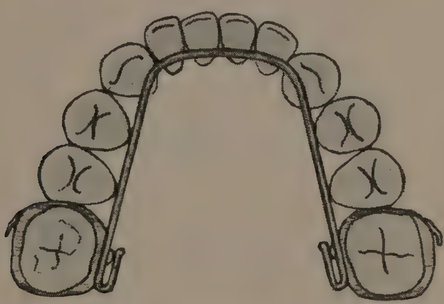


Fig. 789.—Removable lingual arch substituted for labial arch in distocclusion cases.

ment arch to hooks on the mesial angle of the molar anchor bands. Light weight elastics are used in the beginning of treatment increasing to heavier ones as the patient becomes used to the constant pull of the light elastics.

In the unilateral distoclusion cases the elastics are worn on the side in distoclusion only.

The distoclusion cases often exhibit a lack of vertical development in the molar and bicuspid region, and in these cases the wearing of the elastics

in the form of a triangle as shown in Fig. 790 will tend to extrude the molars, especially if a form of bite plane is used anteriorly. In some of the older and more complex cases the occlusal plane is on such an abnormal curve that the bicuspids need to be extruded and the incisors depressed in one of the dental arches as illustrated in Fig. 788. Other methods of con-

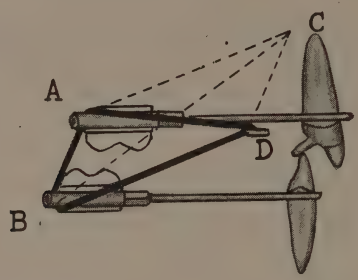


Fig. 790.—Triangular arrangement of elastics in connection with bite plane for correcting occlusal plane.

trolling the occlusal plane will be found under the treatment of Class II, Div. 1. In the arrangement of the appliances for the treatment of Class II, Div. 2, the upper incisors must be moved labially, the upper arch widened and the distoclusion and occlusal plane corrected in the same manner as in the first division of Class II.

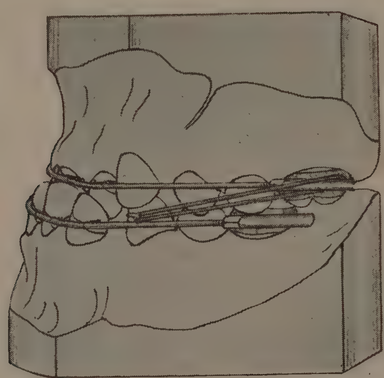


Fig. 791.—Mesial movement of upper teeth and distal movement of lower teeth.

If bodily movement of the anterior teeth is desired in the first or second division of Class II cases either the pin and tube appliance or the ribbon arch may be used to obtain this result.

Mesial Movement of the Upper Teeth and Distal Movement of the Lower Teeth.—This change in occlusion mesio-distally of the upper and lower teeth is necessary in the treatment of Class III, or mesioclusion,

and the application of the intermaxillary force, Fig. 791, is just the reverse of that used for the mesiodistal change in Class II. In the use of the labial alignment arches for producing this change in the occlusion, stationary anchorage in the lower dental arch should be established as nearly as possible by ligating all of the lower anterior teeth, and in some cases supporting the arch wire anteriorly with bands and spurs on several of the anterior teeth. Distal movement of the lower molars except for a slight tipping effect is very difficult to produce, and the effort of the appliances aided by intermaxilliary force, should be the mesial movement of the upper teeth. In their mesial movement through ligation of the incisors and cuspids to the upper alignment wire inclination movement is effected and the occlusion gradually changed. In cases in which the upper anterior teeth bite deeply lingual to the lower teeth, better results may be expected than when the upper anterior teeth bite less deeply. In

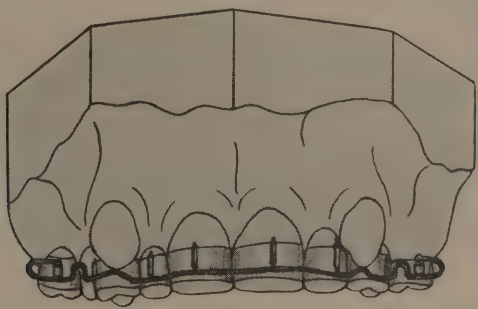


FIG. 792.—The pin and tube arch as used in general arch development.

these latter cases, the upper anterior teeth may even have to be elongated after the occlusion has been changed mesio-distally. Normal arch form and size are first established as in the treatment of distoclusion cases before attempting to change the mesio-distal relationship, and the use of the intermaxillary force as a re-enforced anchorage to the upper molars from the beginning will prevent their distal inclination.

The lingual arch may be used on the upper dental arch in these cases with much satisfaction when the upper anterior teeth do not have to be lengthened, the hooks for the intermaxillary elastics being attached to the buccal surfaces of the upper molar anchor bands. Graduated intermaxillary elastics are used as the case progresses.

Tipping of the upper anterior teeth may be prevented by a very slow movement of these teeth or by the use of attachments such as are available with the pin and tube or ribbon arch to move these teeth bodily.

Application of the Pin and Tube Arch for Various Tooth Movements.—Fig. 792 illustrates the pin and tube arch which has been evolved from the

Angle sectional pin and tube arch, and which is still used in its simplest form by many orthodontists who have familiarized themselves with its use and prefer it in some cases. It will be observed that the .030 inch arch wire is fitted closely into each embrasure and to the curved labial surfaces of the teeth, and that a loop is inserted anterior to the latch lock, the flattening out of this loop assisting in elongating the arch wire.

Manipulation of the Pin and Tube Arch in Treatment.—In simple cases the arch may be left in position and the entire bodily movement of the incisors controlled by opening the loops in front of the half round tubes or straightening out the bends in the embrasures until the appliance feels snugly but not painfully tight. In more complicated cases, it is necessary to remove the arch and change its shape at certain points calculated to produce special tooth movements. Only one of the bends in the arch wire which, when straightened out causes labial movement of the incisors, should be changed at each sitting, leaving the rest of the appliance with the pins in perfect register until the next sitting. The larger bends in the arch wire should be slightly straightened out, when necessary, in such a way that the ends of the arch will always preserve their alignment with the half round tubes on the molar bonds.

FIG. 793.—Rotating incisors with pin and tube arch.

Rotation of Incisors.—In rotation of incisors, the tube is located toward the more lingual angle, Fig. 793, and the arch wire is bent so that it rests

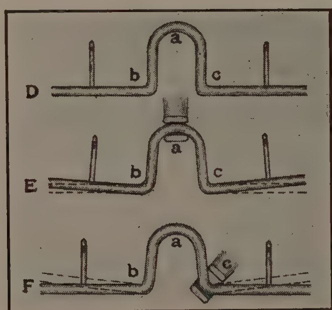


FIG. 794.—Enlarging loops and preserving arch alignment with pin and tube arch.

on the most prominent labial angle of the tooth to be rotated when the pin lies on the labial side of the tube of the same tooth.

Formation and Control of Loops.—In forming the loops on the arch wire a special plier, Fig. 659, designed by Dr. J. Lowe Young, is used and the loops are thus made of a uniform height and of a width capable of proper adjustment.

In connection with the threadless arch with vertical pin and tube anchorage the loops are a most valuable adjunct, as they form the only means of arch wire enlargement in arch development and of mesially and distally directed forces for tooth movement. This force is exerted by slightly straightening out the sharper bends of the loops by flattening them in diagram E, Fig. 794, the angles b and c should also be slightly pinched to with specially designed pliers. For example, if a loop is pinched at a,

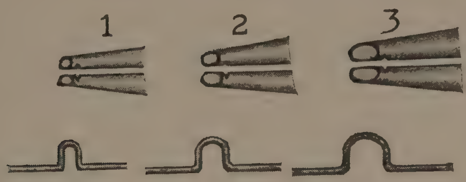


FIG. 795.—Graduated sizes of loop bending pliers.

preserve the alignment of the wire from b to c, as shown in diagram F, Fig. 794. This increases the width from b to c, and lowers the arc of the loop a, and the occasional repetition of this process causes the gradual disappearance of the loop.

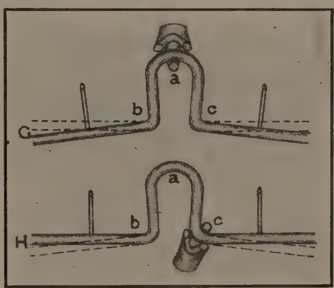


FIG. 796.—Loop contracting plier.

The author has designed a special set of three pliers for enlarging and flattening the loops, Fig. 795, and one plier for contracting the loops, Fig. 796. The three loop enlarging pliers are made with consecutively larger beaks, so formed and designed that the smaller plier is used to flatten the curves of the loop until the beak of the plier is too small for further flattening of the curves, when the next larger plier is used and so on until the largest size plier has been used and the loop entirely disappears. Occasionally the arch wire will need to be twisted on itself to restore alignment or to give a different angle of inclination to one of the pins. In these cases, two pairs of the pliers shown in Fig. 658 should be used, one to hold the arch wire, the other to twist it. In twisting the arch

wire on both sides of a pin, care must be taken to restore the original alignment of the remainder of the arch wire as ascertained by the subsequent fitting of the pins not re-aligned in the tubes.

Bodily Lingual Movement of Incisors.—The positions of the pins are sometimes reversed in Class III cases in which it is desired to move the roots of the lower incisors lingually, the notches of the pins locking on the lingual edges of the tubes as suggested by Dr. J. Lowe Young.

Bodily Mesial and Distal Movements of Anterior Teeth.—In the mesial or distal movement of the anterior teeth with the pin and tube arch, but one tooth at a time should be moved by resoldering the pin the thickness of the wall of its tube mesially or distally as the case may be, leaving the other pins untouched so that the other anterior teeth may be used as anchorage in the lateral movement of the first tooth. After the first tooth has been moved far enough mesially or distally, the next adjoining tooth is moved toward it in the same manner, and so on until all of the anterior teeth have been consecutively and bodily moved.

Treatment of Infraversion of Incisors with Pin and Tube Arch.—By giving a slight bend occlusally in the middle portion of the arch wire distal to the cuspids, the pins being locked in the tubes on all the teeth in infraversion, force is exerted in the line of the long axes of the incisors, and the simpler cases of infraversion may be corrected in this manner. The more pronounced cases may be treated by the additional use of intermaxillary force or with the plain alignment arch.

CHAPTER LI

PRELIMINARY CONSIDERATIONS IN TREATMENT OF MALOCCLUSION

General Considerations.—The conditions involved in individual malocclusions must of necessity be considered in the same general way as are diseases or deformities of other parts of the body.

There should be recorded on a chart the history of the case in a somewhat similar manner to that in vogue in general medicine. The form of chart in use by the author allows of a record of the age, health, and habits of the patient, the possible etiological factors involved, such as the effects of childhood diseases, measles, whooping-cough, diphtheria, symptoms of rachitis, the conditions of the naso-pharynx, noting the presence of adenoids, enlarged tonsils, deflected septi, or enlarged turbinates. Also the association of visual or aural defects should be noted, with the possibility of their having the same general cause as the malocclusion. A study of the various facts brought out in a chart diagnosis of this kind cannot fail to be of great value in prognosis and treatment. In some cases, the history of the patient is of such a nature that treatment of the malocclusion alone is of little value, in others, it is the one necessary thing that will restore the normal function of the masticatory organs, and bring beauty to a face marred by lines of inharmony.

Again, the treatment of the malocclusion may so stimulate the development of structures and sinuses adjacent to the dental arches that better respiration is established, and better nutrition inaugurated through the established function of mastication. The possibilities of benefit to the general health through these and more obscure channels, are worthy of considerations. The lack of development in the dental arches can no longer be considered in the light of local etiology, when such profound symptoms of general disturbance of function, of nutrition, metabolism and bodily growth are found associated with many of the cases presenting with malocclusion.

Some of the cases presenting with marked symptoms of pathological conditions in the nose and throat are apt to have suffered to such an extent the ill effects of the troubles coincident with the "vicious cycle" in which adenoids, mouth-breathing and malocclusion are in evidence, that restoration of normal conditions of either nose, throat or dental

arches seems an impossibility. In other cases, however, if the pathological symptoms have been of short duration, and the orthodontic treatment instituted during a period of general bodily growth, the benefits of dental arch development and stimulation to the growth and healthy condition of the structures of the maxilla and adjacent regions of the internal naries have been very marked.

The effects of habits in malocclusion are so important in their relation to treatment, that unless they are taken cognizance of, failure is apt to ensue. For example, if a malocclusion be caused by thumb-sucking, and the cause of the malocclusion be not prevented during treatment the continuance of such a habit will cause the return of the malocclusion. Habits of thumb and tongue sucking and lip and cheek biting, should be noted and efforts immediately to break the habit found on beginning of treatment of the case. Weakened or abnormal acting muscles should be observed in connection with the malocclusion and their strengthening or correction planned for.

Local Considerations.—In making a diagnosis of the malocclusion, after noting the class, any peculiar features of malocclusion should be taken cognizance of, such as the prolonged retention of deciduous teeth, loss of permanent teeth, absence of germs of permanent teeth, impacted teeth, and supernumeraries. The X-ray should be brought into frequent use in determining the shape and position of the roots of impacted teeth, and supernumeraries, et al.

The relation of arch width to arch length, the height of the plate, and underdevelopment or overdevelopment of bony structures should be taken cognizance of. The depth of the overbite, and conditions involving supra- or infraversion should be carefully noted with a view to their effect upon the articular movements of the mandible, and the possibility of restoration of natural articular as well as occlusal function.

Finally, a study of the case should be made with reference to the problems of dynamics and anchorage involved, and treatment should not be instituted until they are satisfactorily solved.

The beneficient results of treatment should follow along the lines of development of the dental arches, improvement in occlusion and facial lines, in muscular action of the jaws, better masticating powers, better respiration, and better general health.

Length of Time of Treatment.—The length of time of the proposed treatment should be calculated as early as possible from one's experience with similar cases, although an absolutely definite period of time is very difficult to state because of the unknown conditions that have to do with the consecutive progress or otherwise of any case, such as regularity of appointments, illness, long vacations, etc. However, the simpler cases

of dental arch development require at least a year's time to treat, and the complex cases proportionately longer.

Intervals between appointments should be regulated according to the requirements of each case. Patients wearing appliances with ligatures such as labial alignment wires should be seen on an average of once in two weeks on account of the necessity for prophylactic measures, while those wearing lingual arches with or without auxiliary springs will go for longer intervals without attention. Out of town patients wearing appliances without ligatures may have intervals of from one to two months between appointments if they are reasonably careful of their appliances. If patients are careless with their appliances and get them out of repair frequently or do not keep them clean, it will be necessary to give them more frequent appointments than others.

Early Treatment of Arrested Developmental Conditions in the Arches. Any arrested or deficient development of the arches of teeth may be diagnosed in advance of the permanent dentition, and should be stimulated to normal growth and development as early as the age of the patient will allow of the wearing of delicate appliances for the purpose.

The lack of mesial and distal spacing between the deciduous incisors and cuspids at about five or six years of age is a very certain indication of a lack of anterior development sufficient for the proper eruption of the permanent teeth succeeding them.

The upper deciduous arch may be in linguoversion, or the lower arch may be mesial or distal to its normal position, or there may even be infra- or supraversion present in the deciduous teeth, all of these conditions being readily diagnosed.

If the deciduous arch needs developing, it is better to perform this operation some little time before the roots of the deciduous molars have begun to absorb, since the crowns of the permanent bicuspids are enclosed within the roots of the deciduous molars, as may be observed in Fig. 797, and the result of the development will be to move the crowns of these permanent teeth as well as the deciduous teeth and surrounding alveolar tissues into a larger arc, affording a gentle stimulus to the normal development of the entire arch.

If treatment is delayed until just before the time for shedding of the deciduous first molars, the roots of these teeth, being almost absorbed, can offers no resistance to the force of the appliance and their crowns will be shed before any stimulus to growth can be applied in this region, which will then delay the development of these parts of the arch until the permanent bicuspids are fully erupted, there being no other means of anchorage in the meantime, except what may be possibly obtained through the ligation of the deciduous cuspid, which many times is prematurely shed.

The author has obtained the best results in dental arch development between the ages of six and eight years, and in some cases still younger, especially in cases of mesio- or disto-version, in unilateral or bilateral linguoversion of the upper dental arch, and upper protrusions of Class I.

FIG. 797.—Maxillary sections showing bicuspid crowns enclosed within roots of the deciduous molars.

It is reasonable to suppose, from the rapidity of development of the alveolar process during the primary stages of eruption of the permanent teeth, that the movement of the deciduous teeth some little time previous

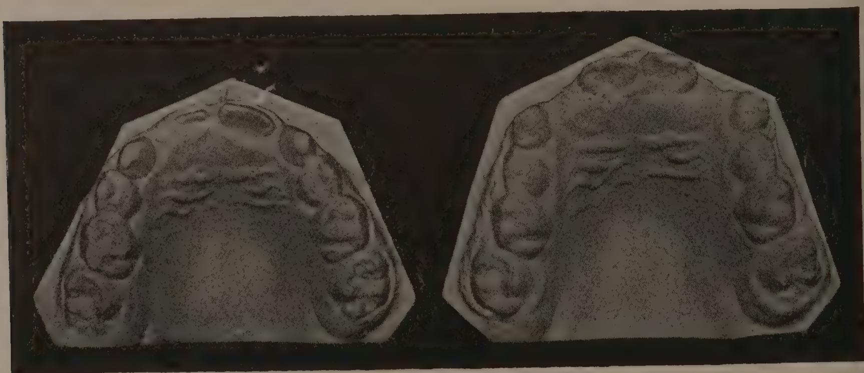


FIG. 798.—Mixed denture in which the deciduous teeth were moved into a larger arch for development of the permanent dental arch.

to the period when absorption of the roots of deciduous cuspids and molars is about to be initiated, conforms most nearly to a natural and physiological process, and that the amount of absorption of alveolar process in

advance of moving teeth is comparatively slight, the change in these structures being analogous to the natural developmental changes which would occur in case no arrest of development had been observed.

Realizing the benefits of such early development of the dental arches, the orthodontic specialist prefers to operate upon the children in whose mouths the presence of firmly implanted deciduous teeth offer a firm resistance for the development of the dental arch in advance of the eruption of the majority of the permanent teeth.

Fig. 798 illustrates the development of an upper dental arch in a case in which the deciduous molars were used for resistance throughout the treatment and the restoration of the proper size and shape of the arches at this age conforms more nearly to a physiological process or a stimulation to normal development, rather than a tearing down and rebuilding process to which such treatment is analogous at a more mature age. Early treatment in a case of this kind is undertaken at a time when the alveolar processes are more cartilaginous in character than later, the teeth being thus more readily moved because of lessened resistance than when the cartilaginous structures are fully calcified.

Again, the function of the dental arches being restored early in child life, all developmental processes in relation thereto, such as the growth of the dental and maxillary arches and the nasal cavities, and the conformation of the muscles of mastication and expression, will have the best chance for normal development, and the attainment of harmony in the profile will thus become a possibility through such normal relationships.

Furthermore, the earlier treatment is undertaken, the less tendency exists for the return of the malocclusion, and the less the need of retention, as age only increases resistance to tooth movement, confirms the deformity in its relationship by long and improper function of occlusion and muscular expression, and initiates structural changes in bony and muscular tissues which cannot be altered by treatment.

CHAPTER LII

TREATMENT OF CLASS I (NEUTROCCLUSION)

Diagnosis.—Malocclusions of Class I (Angle Classification) are recognized by the normal mesio-distal relationship of the dental arches, usually determined by noting the occlusal relations of the mesio-buccal cusps of the upper first permanent molars with the lower first permanent molars, when present in the arches. In the absence of one or more of these teeth of the permanent set, the occlusion of the cuspids or bicuspids will serve to denote the normal mesio-distal relation of the dental arches. When a tooth is impacted, the closing up of the space for its eruption must be taken into account, and the occlusion of all of the erupted teeth must be observed as the cusp relation might in cases of this kind indicate a mesial or distal occlusion either of a molar or bicuspid, and confuse the diagnostician.

The contraction of an upper dental arch will often cause the cusps of the lower first permanent molars to assume a slight distal position, which become normal in their relation on a very little widening of the upper dental arch. This fact should also be taken into account, so that a case exhibiting these peculiarities of deficient development be not diagnosed as belonging to Class II.

A grouping of the principal variations of the anterior malocclusions of Class I is shown in Fig. 799. Within the limits of these variations may be found all the distinctive features of the different forms of anterior malocclusion present in this class, from which the reader may gain some idea of the difficulties of differential diagnosis.

The model **a** in the upper left corner of the group is a not uncommon form of anterior malocclusion found in Class I, the cuspids in labioversion being symptomatic of undeveloped dental arches. A slight variation from this condition in the model **b** exhibits both upper and lower cuspids in labioversion, and the upper dental arch in linguoversion, a still greater degree of arrested development of the dental arches than shown in the model **a**. A further variation of the anterior malocclusion in Class I is shown in the case of the upper protrusion and deep overbite, as illustrated in the model **c**. In these cases the occlusal plane is distinctly abnormal in its curve, the abnormal curve in this instance appearing in the upper arch. In connection with the deep overbite, there invariably exists a condition of infraversion which is causative of the deep overbite. This is

symptomatic of a large number of cases of Class I presenting with a combination of various other conditions of anterior malocclusion.

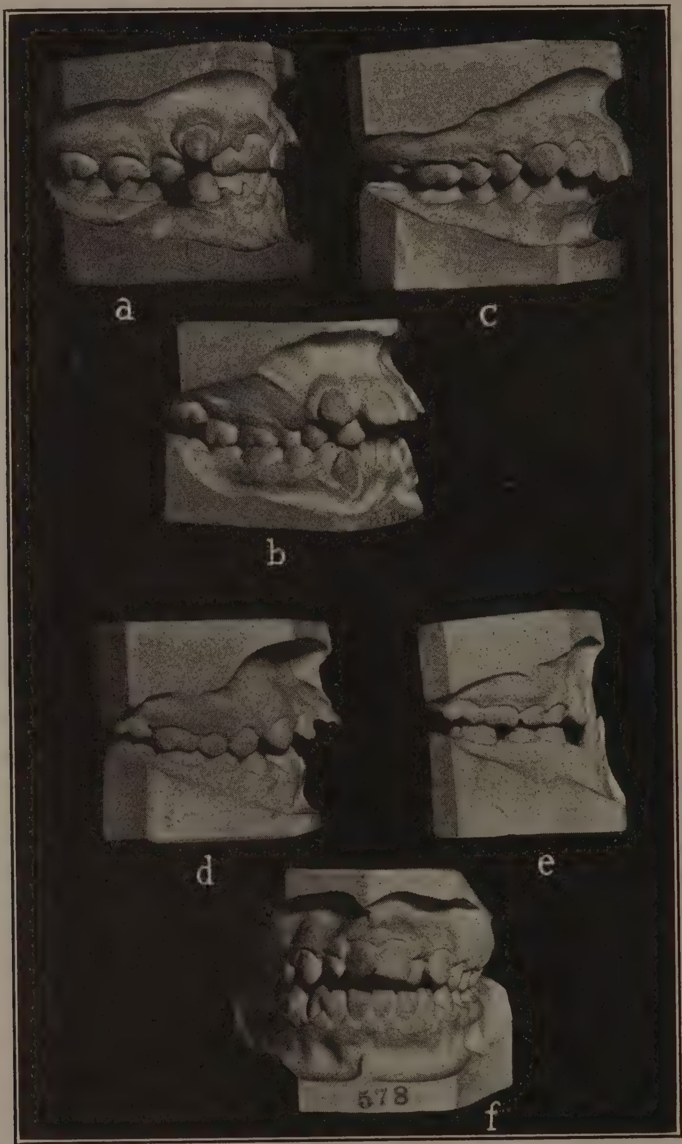


FIG. 799.—Variations of anterior malocclusion in Class I.

The contraction of the upper dental arch in arrested development will often cause the cusps of the lower first permanent molars to assume slight distal portions which become normal in their relations on development

of the dental arches. This fact should be taken into account, so that a case exhibiting these peculiarities of deficient development be not diagnosed as belonging to Class II. In models **d** and **e**, Fig. 799, are exhibited cases of Class I simulating in appearance the anterior malocclusions of Class II and Class III, the differential diagnosis between the three classes often being difficult because of the similarity of the anterior malocclusion.

For example, if the facial inharmony of a case exhibiting an upper protrusion in the anterior malocclusion be taken as a guide without observing the mesio-distal relationship of the dental arches, a case might be thought to belong to Class II, because it exhibited protruded upper incisors and an apparently receding chin, when an examination of the occlusal relations in the molar region would immediately prove it to be one of the not infrequent cases of Class I having only the facial symptoms and the peculiarities of maldevelopment of Class II, such as infraversion of the bicuspids and molars and the deep overbite so common in Class II. Div. I.

Likewise, some cases belonging to Class I simulate the general appearance, in the malocclusion and in the facial inharmony, of Class III, with retruded upper incisors and an apparent protrusion of the lower dental arch and of the chin, while the molar teeth in each lateral half are in the normal mesio-distal relations of neutroclusion.

The occurrence of the symptoms in syndrome in Class I and Class II, and in Class I and Class III, with the single addition of distal occlusion in Class II and mesial occlusion in Class III, leaves some room for doubt as to the vital importance of mesio-distal cusp relationship in some cases exhibiting the same major symptoms of facial inharmony and anterior malocclusion. As an indication of further necessary treatment however, the diagnosis of distal or mesial occlusion still remains as indisputable evidence in the majority of cases of Class II or Class III, although occasionally the indicated treatment of Class I, applied to Class II cases will so change developmental conditions that the distal occlusion disappears without other special treatment instituted therefor.

In the model **f** Fig. 799 is shown one form of infraversion or "open bite" malocclusion of Class I, which may extend to the second and third molars in severe cases. The occlusal plane in these cases is abnormal, and in many cases the angle of the mandible partially disappears.

The many peculiarities of maldevelopment of the dental arches in Class I which have just been described must necessarily exhibit considerable variation in the occlusal plane. Thus there may be observed infraversion of the incisors and cuspids, with the bicuspids and molars in occlusion, or the infra-version may extend to include incisors, cuspids, bicuspids and first molars in extreme cases. Again, there may be infraversion of the bicuspids and molars, with protuding upper incisors and a deep overbite. The

depth of the overbite and the protrusion of the upper incisors will also vary in these cases from a slight protrusion and overbite to the most extreme protrusions of the upper anterior teeth, with the lower incisors biting into the gums three quarters of an inch or more lingual to the upper incisors. The facial lines are correspondingly marred in these cases according to the extent of the malocclusion.

Thus, it will be seen that the variations in occlusal and facial inharmony are more varied in Class I than in any other class, and these factors, together with the multiplicity of malpositions of the teeth, and the simulations in general appearance of the malocclusion of Class II and Class III, makes the class under consideration the most misleading in its characteristics and difficult in its diagnosis.

Relative to the multiplicity of malpositions of individual teeth, in Class I, one or more teeth may be in *bucco-* or *linguo-version*, or in *supra-* or *infra-version*, or in *torsi-version*, characteristics belonging, however, to any of the various classes of malocclusion.

Among the so-called local etiological characteristics noted in this class, as well as in some of the other classes, are the prolonged retention of deciduous teeth, the premature loss of deciduous teeth, loss of permanent teeth, the shortening of mesio-distal diameters of permanent teeth through the ravages of caries, supernumerary teeth, abnormal frenum labium, and the habits of lip or cheek biting, thumb or tongue sucking, and mouth-breathing.

Symptoms of mouth-breathing should be immediately noted, and the case referred to a competent rhinologist for examination of the nose and throat and removal of nasal or pharyngeal obstruction if present.

Other habits such as sucking the thumb or tongue, and biting the cheeks and lips, should be combated from the beginning of treatment, or their continuance will disarrange whatever perfection of occlusal relations that might be attained as a result of treatment.

Extraction, as a beneficial procedure, should be excluded except in rare cases, and usually where it has already been resorted to, the restoration of space which has been lost by contraction in the region of extraction should be accomplished and the space retained by proper methods.

The diagnosis of Class I being indicated by the normal mesio-distal relation of the dental arches, the treatment indicated should be along the lines of dental arch development according to the indications for treatment in the individual case.

Fundamental Principles of Treatment in Class I.—The dental arches being insufficiently developed in either the horizontal or vertical plane in Class I, the treatment should be directed toward their development in the zones or areas of deficiency in the osseous structures of the jaws

through the scientific use of appliances especially constructed for the purpose. The first step in treatment in Class I should be the necessary changes in the horizontal plane in the lateral and anterior development of the dental arches, after which, or during its operation, the labial, buccal, lingual and torsal movements of individual teeth may be inaugurated. Following these changes in arch form and positions of individual teeth, further treatment should be aimed at the correction of infraversion or other abnormal conditions of the vertical occlusal plane, including the abnormal overbite. This is the logical order of treatment of these conditions of abnormal development, and a reversal of the order of procedure would only invite complications in the use of the appliances and a possible failure of the results.

The simpler the combination of appliances and the fewer necessary individual bands upon the teeth, the more ideal the treatment will be, although the control of all of the teeth in one dental arch often requires the most complicated and delicately constructed appliances, especially in cases of bodily movement of the teeth, and in those cases in which a change in the occlusal plane is necessary. The application of forces to the teeth and dental arches is governed by physiological as well as mechanical laws, hence a serious study of the dynamics and anchorage of each case should be made with the idea of utilizing only the proper amount of developmental force which will produce growth stimulation, using the most delicate and least conspicuous appliances, adjusted so as to give the least discomfort to the patient, but also arranged for efficiency in every case.

To follow a consistent sequence in describing the treatment of cases belonging to Class I, those cases, which, on account of their youth, and the greater possibilities, therefore, of the fullest development of the dental arches, will be first described, and next thereafter in order the cases of more mature years in which the lesser development of dental arches is possible.

Treatment of Special Cases. Case I.—Although the malocclusions of Class I present varied malocclusions of the anterior teeth, there is a common type of malocclusion in which the overbite is normal, and the anterior malocclusion simply indicative of lack of development exhibited by lack of sufficient space for erupting incisors.

A case of this character, age nine years, is shown in the occluded casts in Fig. 800. The upper dental arch is deficient in its growth and is in linguoversion on the left side and the indicated treatment is a gentle stimulation to normal development by means of the application of a simple, inconspicuous appliance such as the lingual arch.

An examination of the upper dental arch shows that the deciduous cuspids and molars are still intact and firm in their positions, and capable

of offering sufficient resistance to the appliance for lateral development and of carrying laterally with them the crowns of the permanent bicuspids enclosed by the roots of these deciduous teeth.

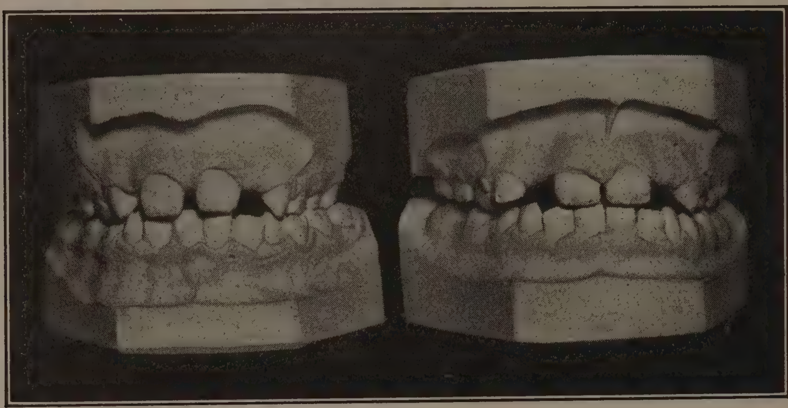


Fig. 800.—Case I. Neutroclusion before and after treatment. Age 9 years.

Although the permanent central incisors and first molars have erupted, as far as development is concerned, it is still a partially deciduous dental arch, and considerable anterior development is necessary in order to

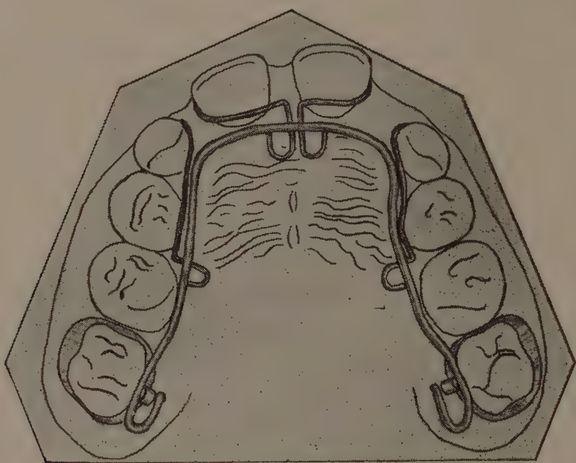


Fig. 801.—Lingual arch with auxiliary springs used for treatment of case shown in Fig. 800

secure sufficient development of the arch for the accommodation of the permanent teeth yet to erupt.

Fig. 801 exhibits the appliance used for treatment of the upper dental arch. A removable lingual arch with auxiliary springs anteriorly for

moving the incisors labially and mesially, and the deciduous cuspids and molars laterally for buccal development of the arch, was placed in position with a slight buccal spring on the side in linguoversion. Very gentle spring force was used throughout the treatment, the patient being seen once in

FIG. 802.—Case II. Before and treatment casts of a case of neutroclusion. Age 5½ years.

two weeks for renewal of the force in the auxiliary springs. The treatment occupied about a year's time after which the lingual arch was used for retention until the eruption of the permanent lateral incisors.

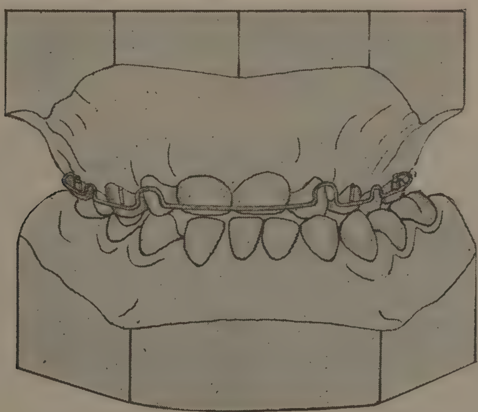


FIG. 803.—Junior pin and tube appliance used to develop the upper dental arch of the case shown in Fig. 802.

The result of the stimulation to arch development and change in occlusion of the upper arch to the lower is shown on the right of Fig. 800.

Case II.—A neutroclusion case of a deciduous dental arch of five and a half years, very similar in its unilateral linguoversion to the case just described, is shown before and after treatment in Fig. 802. The appliance used for development of the upper dental arch consisted of the junior

pin and tube appliance with latch lock anchorage on the molars. The bands on the right cuspid and second deciduous molars were united with a soldered lingual extension wire to re-enforce the anchorage on the right side of the arch. The lateral spring of the .030 inch arch wire widened the dental arch posteriorly by bodily movement so that the lateral half in

Fig. 804.—Case III. Neutroclusion of permanent teeth before and after treatment.

linguoversion gradually developed into normal occlusal relations, while the opening of the loops in the wire between the cuspids developed the arch anteriorly.

Case III.—Fig. 804 represents the right side in occlusion, before and after treatment, of an average case of Class I, the arches being contracted

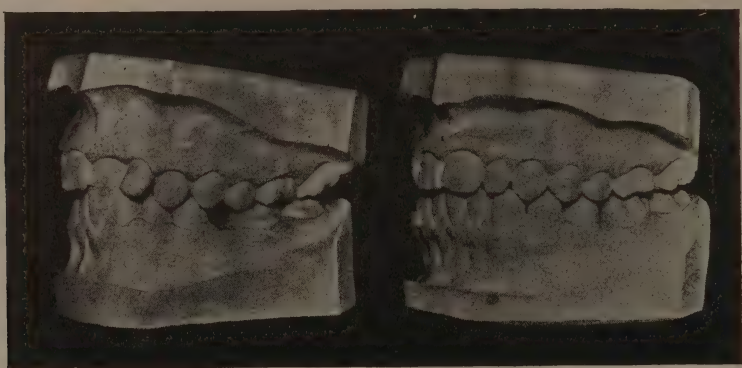


Fig. 805.—Case III. Left side of neutroclusion shown in Fig. 804.

and the teeth anterior to the first molars in various positions of malocclusion previous to treatment. After treatment the teeth are in normal occlusal relations as noted in the model on the right of this figure.

The left side in occlusion, in Fig. 805, illustrates the corrected position on the upper left central from lingual to normal occlusion, and the regaining

of the proper space for, and eruption to normal position of, the left lower second bicuspid. Fig. 806 exhibits the restoration of the normal size and shape of the upper arch, the malposed teeth being placed in the line of occlusion, as noted in the cast on the right of the cut.

Fig. 807 presents the chief difficulties encountered in the case, in the extent of the contraction of the anterior portion of the lower arch, and

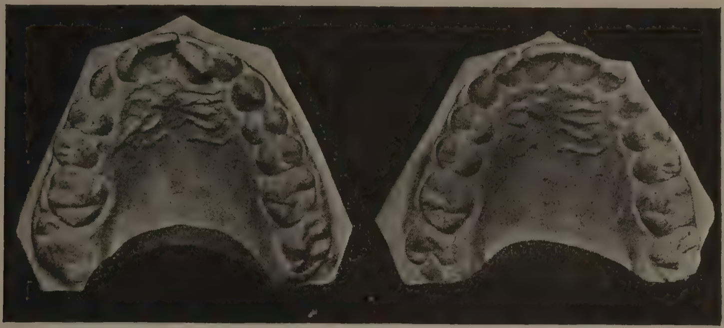


Fig. 806.—Case III. Occlusal view of upper casts.

the attainment of the ideal in the size and shape of the arch as a final result. The lower unerupted bicuspid very quickly took advantage of its release from imprisonment between the first bicuspid and first molar, and erupted into occlusion without mechanical aid, lending its additional support as a keystone to hold the arch intact. The presence of the

Fig. 807.—Case III. Occlusal view of lower casts.

unerupted bicuspid in the alveolar process could be diagnosed by the protuberance of the gum tissue overlying the tooth, without the use of the X-ray diagnosis often necessary in these cases.

The appliances used in this case were the alignment arch and molar anchor bands. In the upper arch, the left central was banded, and a ligature extended from a lingual spur to the arch, with a rubber wedge

between the mesial angle of the tooth and the arch to assist in its rotation. Very little development was needed in the upper arch beyond that necessary for the accommodation of the left central, and the harmonizing in size of the upper with the lower arch.

In the lower arch considerable lateral development was necessary, and the appliances were adjusted so as to obtain reciprocal anchorage from one side of the arch to the other through ligatures on the alignment arch. The left lower first bicuspid was banded, and a ligature extended from a mesio-lingual lug on the band to a spur on the arch wire, so as to secure the two necessary movements of rotation and lateral re-alignment of this tooth.

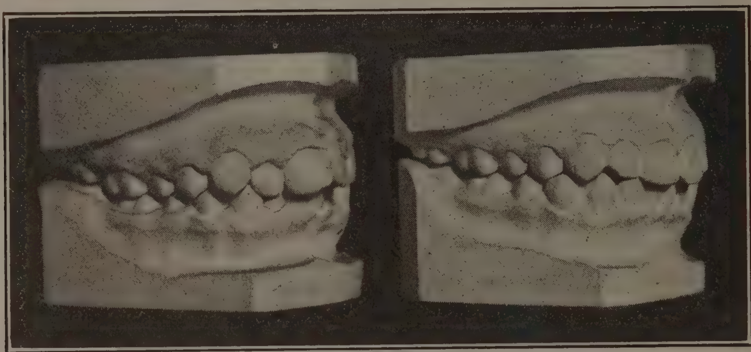


Fig. 808.—Case IV. Neutroclusion exhibiting lack of development of both dental arches, before and after treatment.

Case IV.—The average simple cases of Class I, after the eruption of the permanent teeth up to and including the second molars, present the appearance of the case shown on the left in Fig. 808, the upper and lower dental arches being arrested in their lateral and forward development and the teeth anterior to the first molars in various positions of malocclusion. These cases are easily developed by *inclination movement* to the normal in occlusal relations as shown in the after treatment model on the right of Fig. 808 .

Fig. 809 exhibits the restoration of the normal size and shape of the upper and lower arches, the malposed teeth being placed in the line of malocclusion, as noted in the cast on the right of each cut.

The appliances used in this case were the plain threaded alignment arches to which the anterior teeth were ligated with silk ligatures for inclination movement, as shown in the upper arch Fig. 810. The case needed very little, if any, development in the molar region, which is typical of the treatment of many similar cases of Class I.

The retention of this case consisted of soldered lingual arches attached to the molar bands, to retain the general development, and of individual

FIG. 809.—Case IV. Occlusal views of upper and lower casts, before and after treatment.

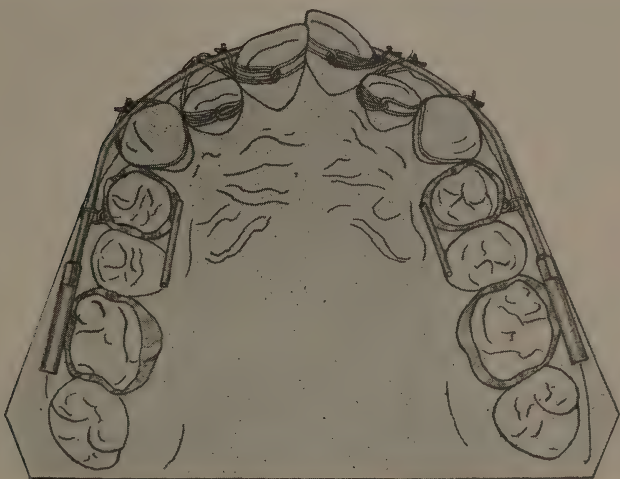


FIG. 810.—Case IV. Alignment arch used for developing upper dental arch.

bands upon rotated teeth with spurs labially and lingually placed to prevent rotation.

FIG. 811.—Case V. Neutroclusion of permanent teeth before and after treatment.

In cases of this degree of simplicity *inclination movement* of the teeth is all that is necessary when other conditions, such as the normal growth

FIG. 812.—Case V. Occlusal views of upper casts before and after treatment.

of the body as a whole, are favorable, and the use of appliances for bodily movement would be not only unnecessary, but inadvisable.

The case just illustrated, although presenting some difficulties in treatment, is simple compared with the problems of normal arch and occlusal restoration exhibited in the treatment of the next case, the right occlusion, before and after treatment of which is shown in Fig. 811.

Case V.—The case is that of a boy fourteen years of age, and in the model on the left of Fig. 811 may be noted the contracted arches, and the closing up of the space for the upper second bicuspid and the partial closure of the space for the lower bicuspids, which are impacted in the alveolar process just external to their positions in the arch.

The etiological factors in this case were obscure, in that the boy was a normal breather, had a good history, and, beyond the premature loss

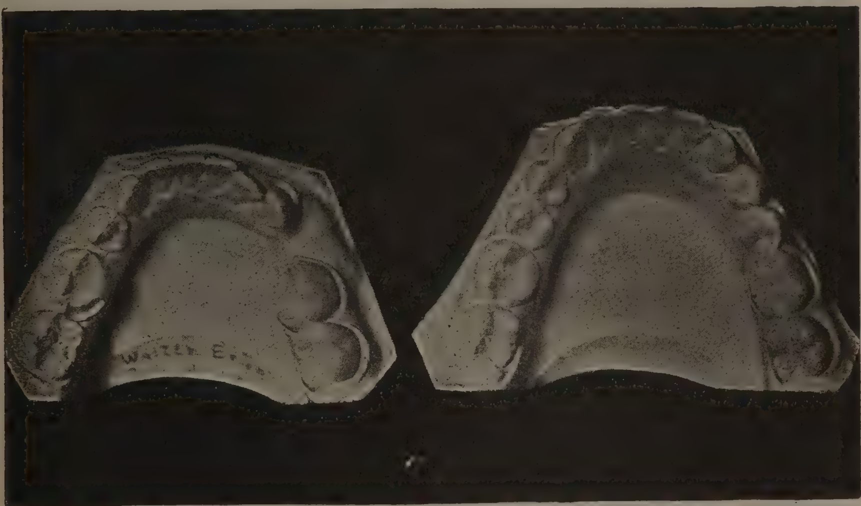


FIG. 813.—Case V. Occlusal views of lower casts before and after treatment.

of the deciduous cuspids and molars as a mechanical factor in the causation of the undeveloped arches, very little could be learned of a pathological nature which might have retarded the normal development of the dental arches.

The occlusal view of the upper casts, before and after treatment, in Fig. 812, exhibits a degree of dental arch development which would not have been believed possible by the uninitiated in the secrets of occlusal restoration. The upper second bicuspid on the right side was freed from impaction, and erupted to its proper position of occlusion, the cuspids also being restored to alignment, or rather the rest of the teeth in the anterior part of the arch changed to the cuspid alignment, as the cuspids were more nearly in their normal positions than any of the other anterior teeth.

The lower cast on the left of Fig. 813 exhibits the impaction of three teeth, two bicuspids on the right side and the second bicuspid on the left

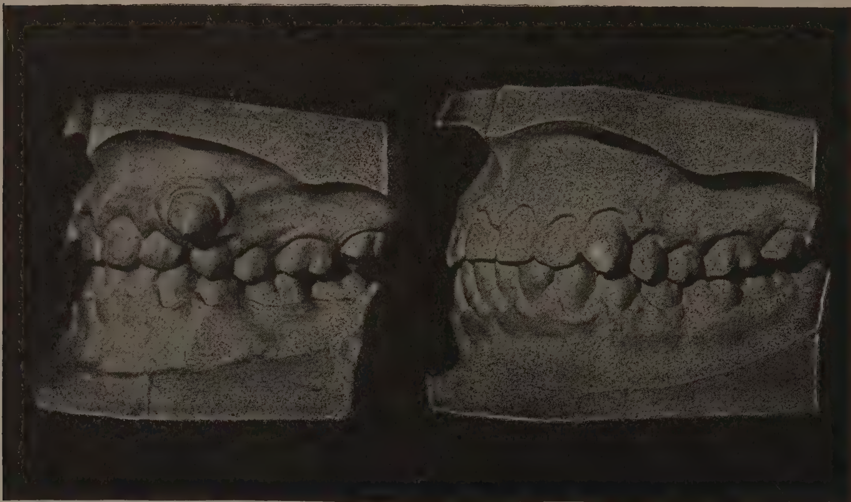


FIG. 814.—Case V. Left occlusion before and after treatment.

side, the release of which could never have been possible without the assistance of the orthodontist. In the cast on the right, the successful accomplishment of the necessary development for the accommodation of these teeth in the arch may be noted. By comparison of the before and after casts of both upper and lower arches in this case, the unusual amount of lateral development may be observed, showing how far short nature came in the development of the arches, and indicating the possibilities of orthodontic science in the restoration of the normal in development and the ideal in occlusion and harmony of contour of the arches of teeth.

FIG. 815.—Case V. Profile of patient after treatment—age 14.

The picture of the left occlusion of the case before and after treatment, in Fig. 814, needs no description. The result of ideally correct treatment without extraction is very evident, and the classic lines in the after-treatment model can scarcely be excelled in beauty by any masterpiece of the sculptor's art. Notice the graceful curves of the acrhes, the symmetry and

proportion of contour, the wonderful harmony which prevails in the arches through the perfect adjustment of each occlusal inclined plane of the antagonizing teeth to the requirements of normal occlusion.

The accompanying profile of this patient in Fig. 815 is shown to illustrate the fact that such an extensive operation of development of the dental arches does not produce undue protrusion of the upper and lower lips.

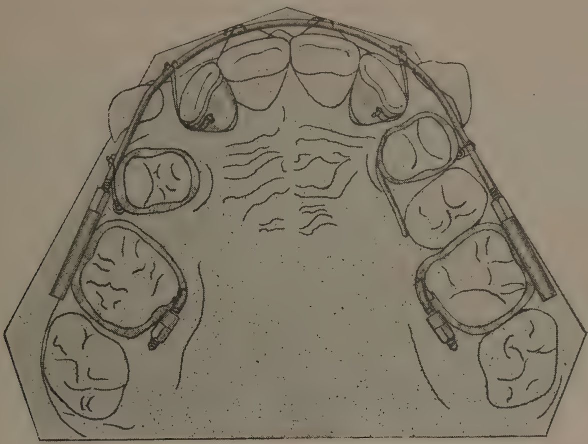


FIG. 816.—Case V. Alignment arch on upper arch ligated for inclination movement.

The lower part of the face is entirely in harmony with the rest of the features, being proportionate for its type, and in its contour hardly suggestive that an operation of this extent had been performed upon the dental arches.

The appliances used in this case were light alignment arches fitted in buccal tubes on first molar clamp bands, and in the extent of dental arch development, and the opening of the unusual number of spaces necessary for the accommodation of the teeth which were either partially or wholly unerupted, the treatment offered the severest test that could be expected of an appliance in the development of the dental arches.

In the upper arch, Fig. 816 the lateral incisors and right first bicuspid were banded and ligated to spurs on the expansion arch from spurs attached to the disto-lingual angles of these bands, directing the force upon these teeth so that their mesial movement was effected by turning up the nuts in front of the buccal tubes.

The left first bicuspid was banded, with a lingual wire attached to include the second bicuspid in the lateral development, and a labial ring soldered near the mesial angle from which a wire ligature was attached to a distally directed spur on the alignment arch, preventing the mesial move-

ment of the bicuspid during the turning up of the nuts, in the development of the anterior part of the arch.

The alignment arch was placed in position with a medium buccal force, B^2, and the ligatures tightened and occasionally renewed, the nuts in front of the buccal tubes being turned up snugly at each visit of the patient. The teeth were moved entirely by *inclination movement,* and the result in occlusal restoration and development of the apical zones in incisor and cuspid region fully justified the theory that in many of the severe cases of undeveloped dental arches, treatment by inclination

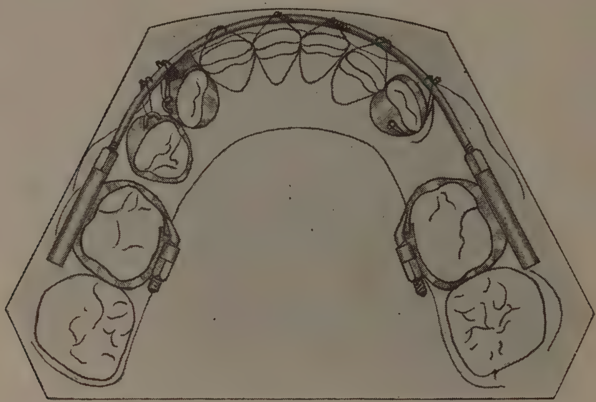


FIG. 817.—Case V. Alignment arch on lower arch ligated for inclination movement.

movement is warranted and advisable, when through such treatment, stimulation to normal development of the dental arches is secured.

The arrangement of the alignment arch, applied with medium buccal force in the lower dental arch, Fig. 817 was very similar to that in the upper, the supporting clamp bands being attached upon the first molars, the lingual screws pointing distally and engaging the second molars. The opening of the bicuspid spaces was effected by ligating the banded first bicuspid on the right side and the banded cuspid of the left side to spurs on the alignment arch, and turning up the nuts in front of the buccal tubes once a week, tightening and renewing the wire ligatures as indicated.

The upper arch was retained by a roofplate, and a lingual wire connecting bands upon the cuspids. The retention of the lower arch was secured by a lingual arch wire from cuspid to cuspid and lingual wire extensions distally from the cuspid bands. A more adequate retention of both the upper and lower arches would be indicated at the present time than was used at the time this case was treated (1902). The development of the arches would be retained by lingual arches attached to first molar bands and the rotated teeth retained by individual bands and spurs.

Case VI.—A neutroclusion case which is very interesting in the peculiarity of its malocclusion, and in the combination of appliances and anchorage used for its treatment, is illustrated from the occlusal aspect of the upper arch before treatment in Fig. 818, the feature of particular interest being the disto-lingual position of the upper right cuspid, which, on account of its extreme distal position opposite the lingual embrasure between the two bicuspids, is apparently secure in its malocclusion, presenting unusual obstacles to its restoration to the line of occlusion.

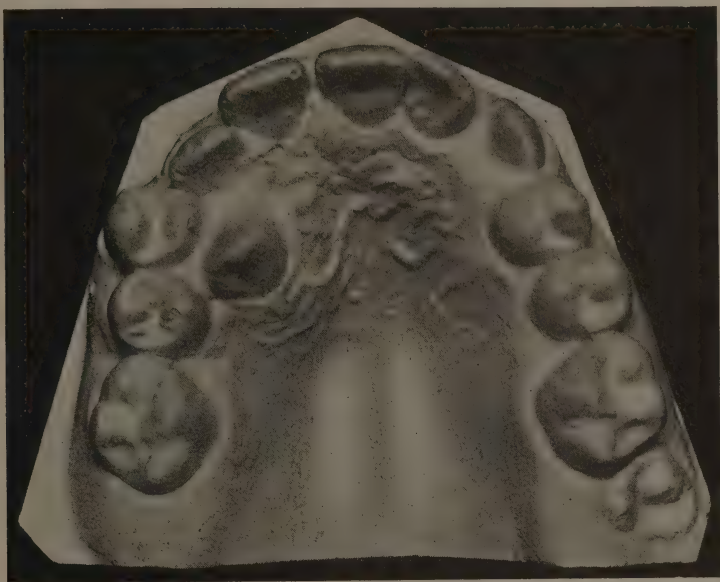


FIG. 818.—Case VI. Occlusal view of upper arch before treatment.

By a careful conservation of anchorage and operation of the appliances, the accomplishment of the desired result was secured, as shown in the after-treatment cast of the upper arch in Fig. 819.

The alignment arch alone with its usual re-enforcements by ligatures for development of the arch, is entirely inadequate to produce the desired results in a case of this kind, for although the space for the right cuspid could be regained by a proper direction of ligatures on the alignment arch, the control of the cuspid in linguoversion in this same manner is impracticable.

The cuspid was first moved forward opposite its regained space by means of a traction screw operating from the first molar anchorage, being attached to the lingual screw, as seen in Fig. 820, the right angled end

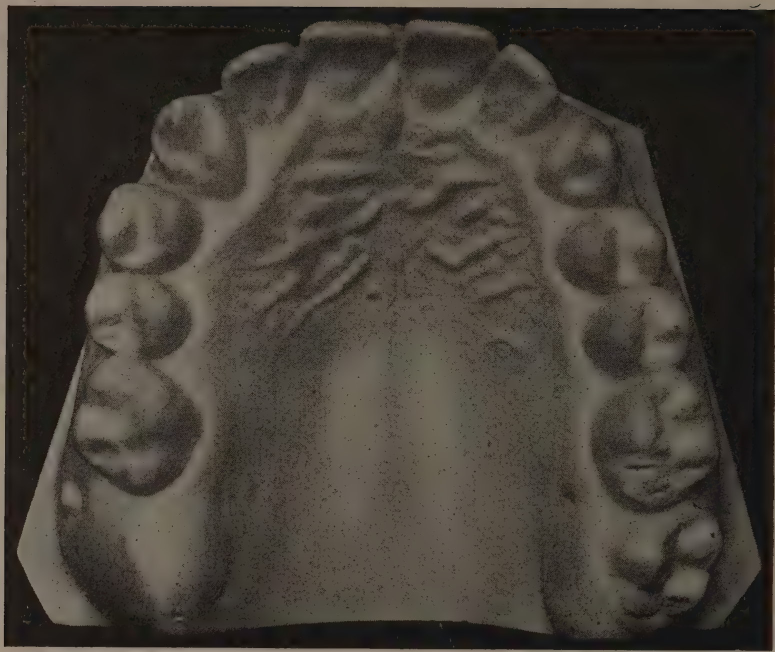


FIG. 819.—Case VI. Occlusal view of upper arch after treatment.

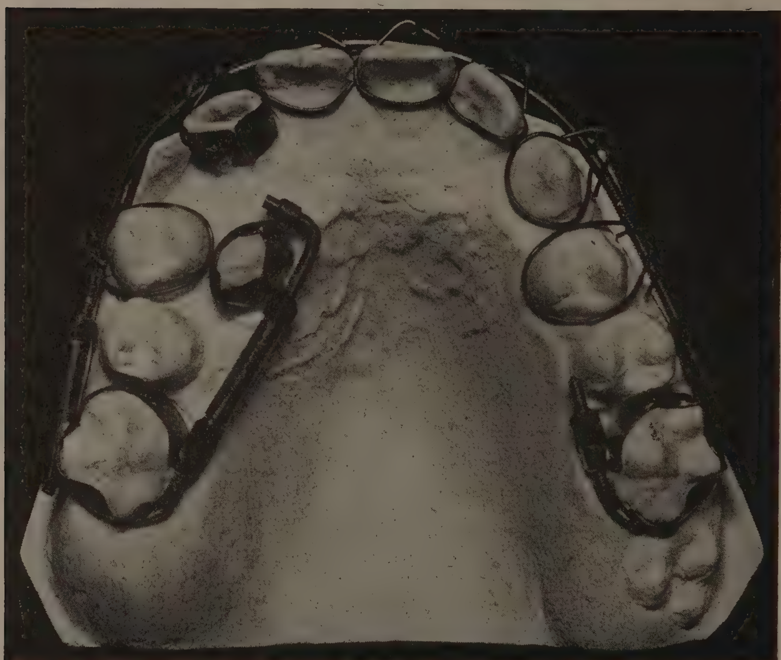


FIG. 820.—Case VI. Appliances used on upper arch.

operating in a horizontal tube soldered to the mesial surface of a band upon the cuspid.

The alignment arch was in operation at the same time enlarging the entire arch and making room for the cuspid, the incisors being directed toward the opposite side of the dental arch by spurs located toward

Fig. 821.—Case VI. Re-enforced anchoraged using intermaxillary anchorage to prevent tipping of upper molars.

the left side of the arch from each incisor, and the right lateral having a band with a lingual spur for more positive action of the ligature at this point.

It is evident that the combined distally reacting forces of the alignment arch on the buccal, and the traction screw on the lingual side of the

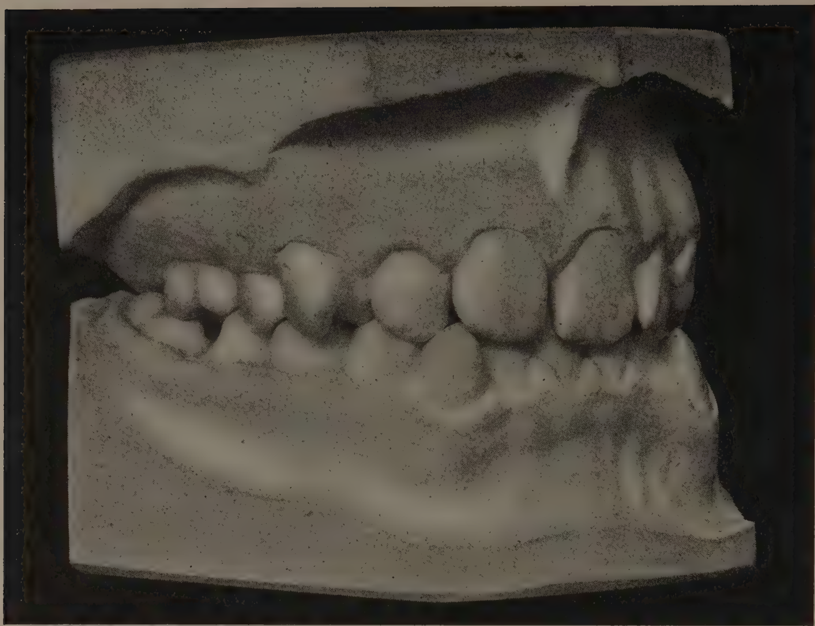


FIG. 822.—Case VI. Right occlusion before treatment.

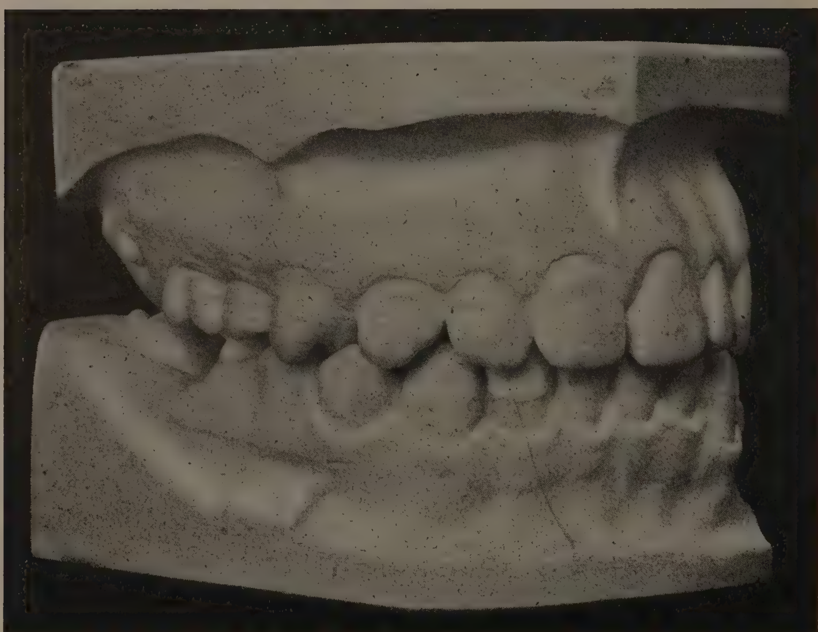


FIG. 823.—Case VI. Right occlusion after treatmen t.

first molar, would be greater than the resistance of the first molar without re-enforcement, and the use of intermaxillary anchorage for this purpose as illustrated in Fig. 821, effectually counterbalanced the tendency to distal movement of the molar, so that the forces acting mesially from this base could operate without disturbing the stability of the anchorage.

The treatment of the lower arch was comparatively simple, requiring lateral and anterior development to harmonize the occlusion with that of the upper arch, at the same time regaining the full space for the lower right first molar, part of the mesio-distal diameter of which had been lost through caries.

The success of this combination of appliances for inclination movement may be noted in the right occlusion, before and after treatment, in Figs. 822 and 823, the cuspid occupying its normal position in the arch, and the occlusion of both arches being restored to harmonious cusp relationship. This case was treated at a date when the larger gauge alignment arches and clamp bands, and the traction screw, were in general use by orthodontists. At the present writing this case would have been treated with lighter gauge alignment arches and plain molar bands, and the cuspid in linguoversion would have been moved into position by an auxiliary spring from a lingual arch. If bodily movement were deemed necessary, the ribbon arch could have been used.

Variations in the Occlusal Plane in Class I.—The occlusion of the upper with the lower incisors in Class I has a wide range of variance from the "end to end bite" to the lapping of the upper over the lower incisors in the cases simulating Class II, Div. 1 so as to completely hide the latter from view when the lips are parted and the teeth closed. Often the lower incisors are elongated and occluding on the gums lingual to the upper incisors. This condition is usually due to infraversion of the bicuspids, or molars, sometimes to a supraversion of the incisors at the same time. The plane of occlusion of the upper arch, instead of being convex is concave, and the treatment for this condition is the same in Classes I and II. One method for its treatment consists in the wearing of a bite plane for opening the bite in the incisor region, while the triangular use of the intermaxillary elastics as in Fig. 790 elevates the molars into occlusion. This method of treatment should be instituted, if possible, before the eruption of the bicuspids so that they may be made to seek the new plane of occlusion in eruption, and thus permanently retain the established occlusion.

Another method of treatment of this condition of infraversion, which is applicable only after the eruption of the bicuspids, is to apply the light alignment arch as a double elastic lever springing it downward over hooks on upper bicuspid bands and under hooks on upper incisor bands, as in

Fig. 787. A lingual arch attached in a similar manner can be used for retention.

Infraversion of Incisors and Cuspids.—The peculiar condition of arrested development of the anterior portion of the dental arches in which there is a lack of occlusion of the incisors and cuspids, is known as infraversion of the incisors and cuspids, or if of greater extent, as infraversion of the incisors, cuspids, and bicuspids, et al. and when occurring in Class I, is considered as the most undesirable complication.

Cases exhibiting infraversion of the anterior teeth in Class I are usually mouth breathers and the extent of the "open bite," as it is sometimes called, varies according to the aggravation or extent of the mouth breathing.

As this condition is essentially a lack of normal development of the anterior portion of the arches, and an abnormal development in many cases of the posterior part of the arches, cases presenting with infraversion of the anterior teeth should be treated as early as possible, and especially, normal habits of breathing should be restored at the same time so that development may not be further impeded by any nasal or other respiratory obstruction.

Oftentimes this condition is caused by tongue, lip, or thumb sucking, and only in so far as these habits can be overcome will treatment be successful without permanent retention.

In many of the simpler cases presenting, the infraversion of the incisors and cuspids seems to be confined to the upper arch alone; in the more complicated cases, the infraversion is shared by each dental arch, which seems to fail of reaching the common occlusal plane. In these more complex cases the mandible is bent downward through abnormal muscular action in mouth breathing, and the facial lines are very much out of balance.

Case VII.—A simple case of infraversion of the incisors and cuspids in a child nine years of age is illustrated in Fig. 824. The infra-occlusion in this case is confined to the premaxillary portion of the upper arch, and the causative factor was rather obscure. The patient was a mouth breather, and there was a lack of development of the nasal passages which probably had much to do with the lack of development of the premaxillary portion of the upper arch.

In simple cases of infraversion of the upper incisors and cuspids, the use of the smaller gauged alignment arches, sprung downward anteriorly and the incisors and cuspids ligated thereto, will stimulate the vertical development of the premaxillary region and restore the anterior teeth to their proper position in the occlusal plane. Fig. 825 illustrates the use of a small gauge alignment arch in this manner for the treatment of the infraversion shown in Fig. 824.

The labio-lingual arch with the anterior bow resting on spurs on the labial surfaces of the incisor bands may be manipulated for treatment of the simpler cases of infraversion of the incisors by bending the lateral loops to cause downward pressure on the arch wire.

FIG. 824.—Case VII. Neutroclusion exhibiting infraversion (left) cast after treatment (right).

The treatment of the more extensive cases of infraversion of the anterior teeth requires a more complex method of treatment than has been described for the simpler cases.

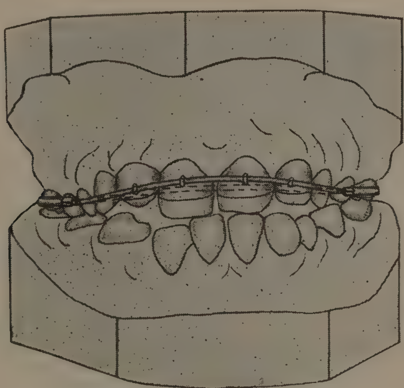


FIG. 825.—Case VII. Correcting infraversion of upper incisors and cuspids with the alignment arch.

Case VIII.—A more mature case of infraversion of the anterior teeth extending as far distally as the second bicuspids is shown before and after treatment in Fig. 826, the after-treatment model representing as nearly the ideal in treatment of these conditions as it is possible to attain.

In the treatment of a case of this character, intermaxillary anchorage should be established between the anterior parts of the upper and lower arches, and the alignment arches adjusted over spurred bands with the intermaxillary elastics extending from hooks on the lower alignment

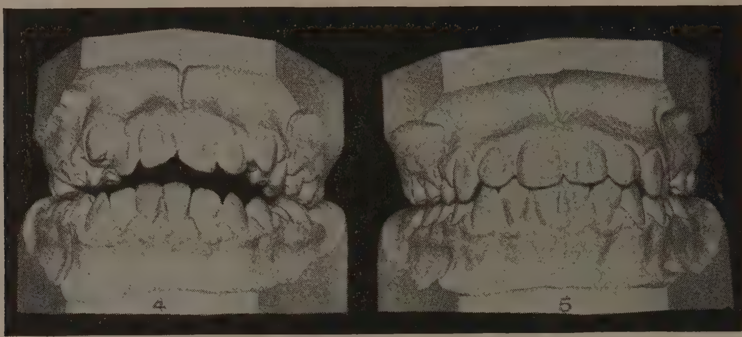


FIG. 826.—Case VIII. Neutroclusion with extensive infraversion of anterior teeth before and after treatment. (*Lourie.*)

arch to hooks on the upper alignment arch, as shown in Fig. 827. It is necessary to first obtain the normal shape and size of each dental arch

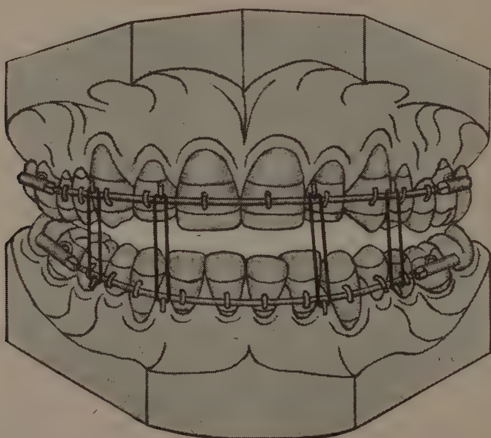


FIG. 827.—Case VIII. Adjustment of alignment arches and use of intermaxillary force for correction of infraversion of anterior teeth.

before applying the intermaxillary force. The elastics should be worn as continuously as possible and should be adjusted so as to operate very slowly in order not to move the teeth out of their sockets in advance of the developing downwards or upwards of the maxillary processes.

It is possible to treat the simpler cases of infraversion of the anterior teeth of Class I without the use of individual bands upon the teeth, the wire of silk ligatures around the incisors and cuspids and other teeth sufficing to move these teeth as desired. However, cases of any difficulty respond much more quickly when the individual teeth are banded, with spurs extending from the bands over the alignment arch.

After the age of development has passed, the difficulties attendant upon retaining the teeth in occlusion, even though the operation might be otherwise possible and feasible, render it advisable in many cases to perform the simpler operation of extensive grinding of the molars and bicuspids until occlusion is obtained, even if the vitality of one or more of the molars be sacrificed in so doing.

The author has obtained good results from this procedure in adult cases, observing, however, great care that a certain amount of cusp articulation is preserved in order that the functions of articulation and mastication may not be interfered with. In other words, the molars should not be ground off flat, but grooved for cusps as in grinding artificial teeth for articulation. The operation is a difficult one, in that it requires the greatest care not to grind too much upon certain teeth and not enough upon others. Occlusal contact points should be ground a little at a time, on one side of the arch and then upon the other, approximating the arches of teeth only a limited amount at each of several sittings until occlusion is obtained.

The shortness of the lips, especially the upper lip, in most of these cases is such as to preclude the idea of elongation of the incisors to occlusion, an unnatural length being unesthetic.

Infraversion of Anterior Teeth Involving Change of Angle of Mandible.—In the severest cases of infraversion of the anterior teeth, including the bicuspids and first molars the facial lines are very much disfigured, the angle of the mandible being apparently bent downward very obtusely, and the naso-mental distance greater than normal. This condition, described by Carabelli as "Mordex apertus," is more of a deformity of the mandible than of the teeth and their processes, but is found in the three main classes as noted by the mesio-distal relationship of the dental arches, and until a simpler classification of these mandibular deformities is found, it would seem reasonable to include them in the "three-class scheme" of Angle's classification, where their individual peculiarities may be described, and special treatment indicated.

The causative factors, while very obscure, seem to be involved with mouth breathing, and abnormal working of masticatory muscles, and with the diseases of childhood, especially rachitis (Lind). It would appear to the author that this condition is largely one of faulty respiration, which

induces wrong muscular action upon the mandible, which becomes deformed as a result of the abnormal action of these muscles upon its surface, the form and structure of the bone being an expression of bone function. Some of these cases seem to have rachitic tendencies, others not.

The treatment of advanced cases of this type is not attended with any degree of success, but if undertaken when the cases are incipient, in the early stages of childhood, good results may be obtained by the use of a headgear and chin cap such as has been described by Drs. Law and Lind.*

FIG. 828.—Lind headgear and chin cap for treatment of "Mordex apertus."

Fig. 828 illustrates the Lind headgear and chin cap. By the use of his apparatus at night only in very young children for a comparatively long period, the anterior teeth may be brought together and retained.

The Lind apparatus depends upon the use of heavy elastics in front of the face from headgear to chin cap, while the Law apparatus has the heavy elastics adjusted from the side of the headgear exerting more of an upward and backward pull.

Case IX. Infraversion of Bicuspids and Molars.—Figs. 829 and 830 illustrate a Class I case of infraversion of the bicuspids and molars. This condition is a very unusual one, presenting as it does, with the incisor region in perfect normal occlusal relations and an entire lack of occlusion from the cuspid to the second molar on each side. The patient was fifteen years of age and the function of mastication was limited to the six anterior

* Transactions European Orthodontia Society, 1913.

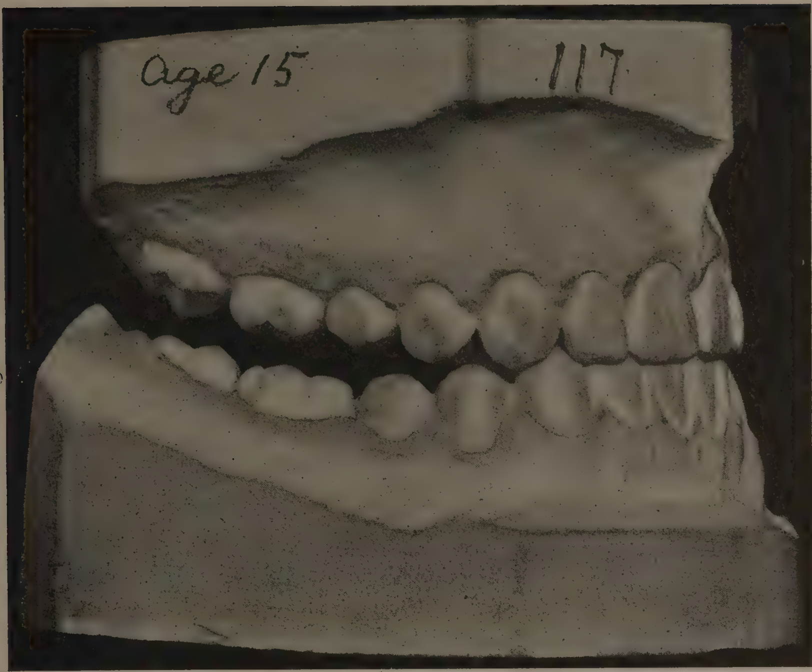


FIG. 829.—Case IX Infraversion of bicuspids and molars (right side). (*Kemple.*)

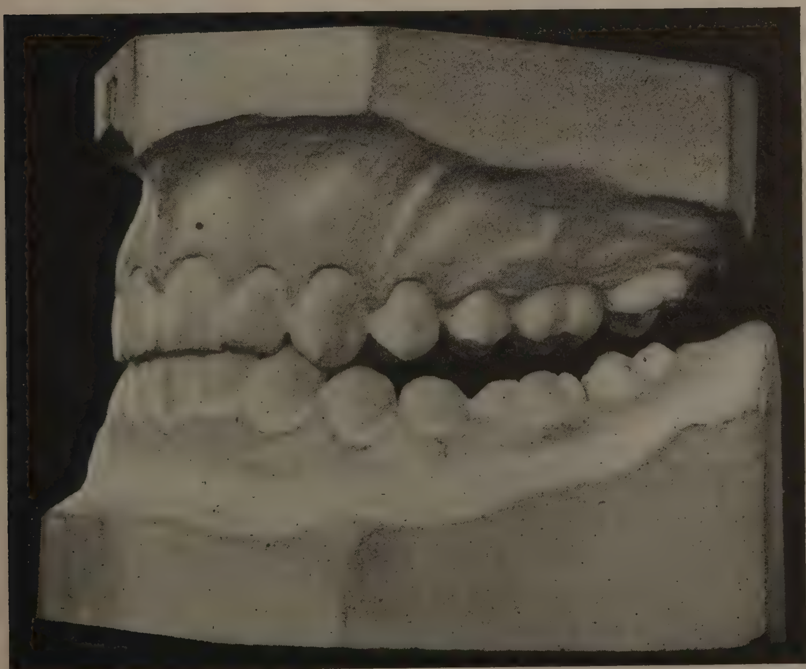


FIG. 830.—Case IX. Infraversion of bicuspids and molars (left side). (*Kemple.*)

teeth in each arch. Such peculiarities of abnormal development are hard to explain, yet the fact that they exist ought to bring to bear a much closer study of the underlying factors in development which produced them.

In the treatment of this case, Fig. 831, heavy alignment arches were adjusted to each arch, using the first molars as a primary anchorage for the clamp bands, banding the eight bicuspids, with spur extensions over the alignment arches above and below. The incisors and cuspids were allowed to remain free from ligation, as they were not to share in the movements to be undertaken.

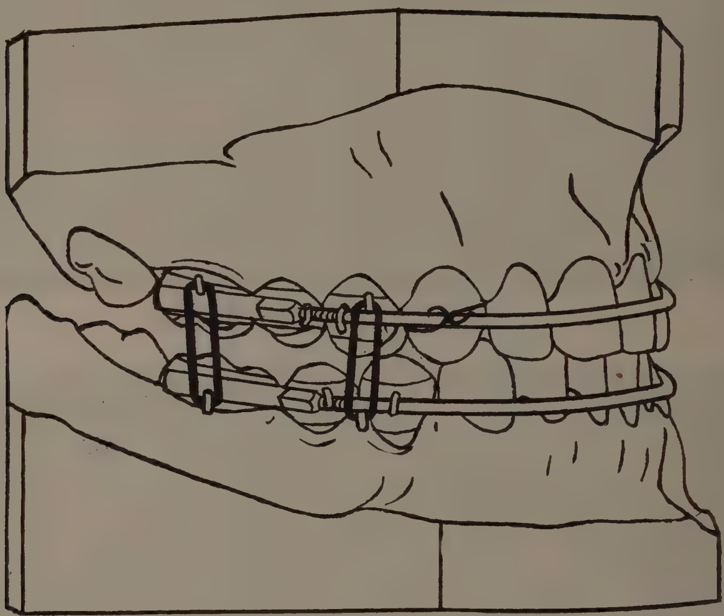


Fig. 831.—Case IX. Heavy alignment arches in combination with intermaxillary force for correction of infraversion of bicuspids and molars.

Intermaxillary elastics were then adjusted between spurs on the buccal tubes of the molar clamp bands and from each alignment arch in the region of the first bicuspids.

The after-treatment models of the case are shown in Figs. 832 and 833, showing the bicuspids and molars have been drawn into occlusion with each other, and a very successful result obtained. The retention consisted of a continuation of the use of the intermaxillary force in connection with a more delicate and inconspicuous appliance for an indefinite period.

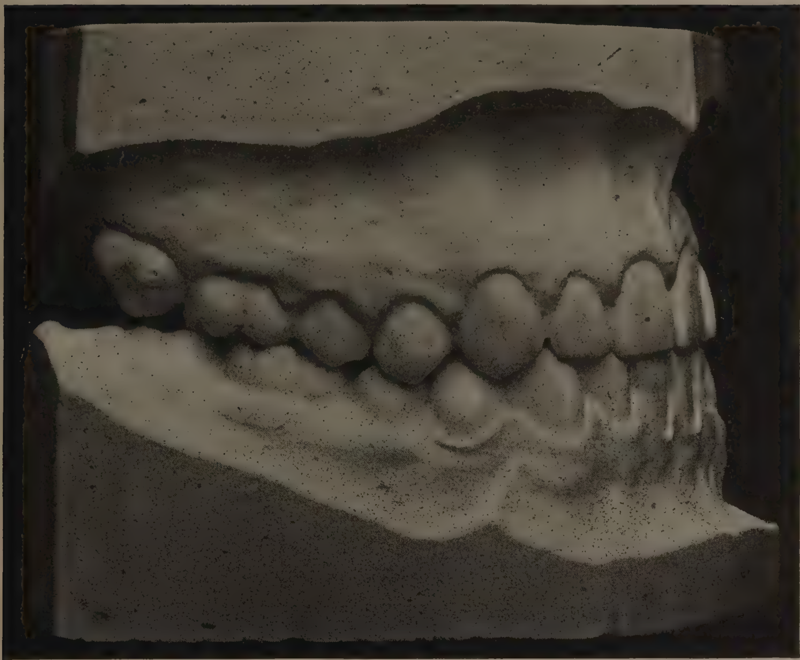


FIG. 832.—Case IX. After treatment casts of infraversion of bicuspids and molars shown in Fig. 829 (right side). (*Kemple.*)

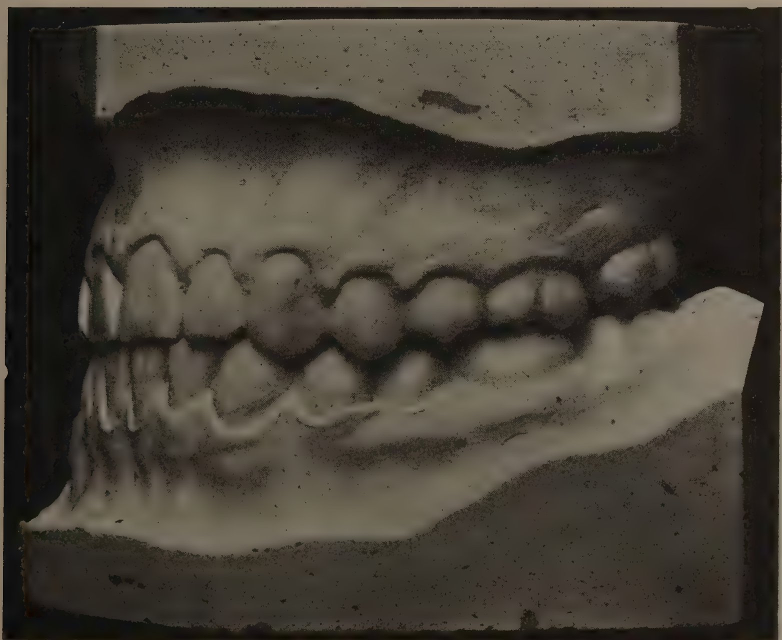


FIG 833.—Case IX. After treatment casts of infraversion of bicuspids and molars shown in Fig. 830 (left side). (*Kemple.*)

Upper Protrusion of Class I Simulating Class II, Div. 1. Case X.—Fig. 834 exhibits an upper protrusion of Class I with all of the symptoms of the first division of Class II, Div. 1 except the distal occlusion. The

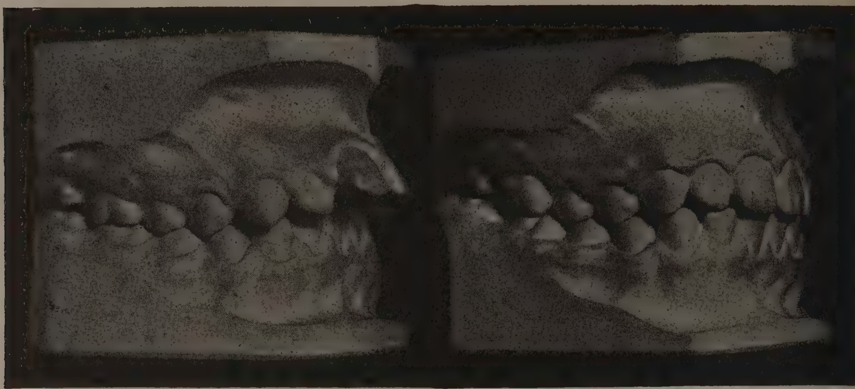


FIG. 834.—Case X. Upper protrusion of Class I simulating Class II, Div. I—before and after treatment.

occlusal planes of both arches were not very much out of proportion, except for the infraversion in the bicuspid and molar region, but owing to abnormal lip habits, the upper incisors were very much protruded. The arches were both narrow anteriorly and the alignment arches were applied

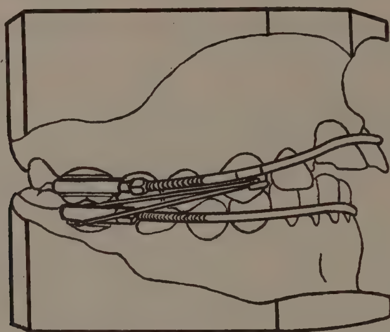


FIG. 835.—Case X. Treatment with alignment arches and intermaxillary force of upper protrusion of Class I.

for their lateral development and the intermaxillary elastics attached to retrude the upper incisors, as in Fig. 835 the upper alignment arch being allowed to slide distally in the buccal tubes by unturning the nuts in front of the anchor tubes. The resistance of the entire lower arch was enlisted by ligating all of the eight anterior teeth to the lower alignment arch, allowing the nuts to remain stationary after the development of the lower arch was completed. The intermaxillary force was thus directed almost wholly against the labial surfaces of the upper incisors which responded

quickly to this treatment, the result of which is seen in the after-treatment model in Fig. 834.

Upper Protrusions of Class I Simulating Class II Div. 1. Involving Infraversion of Bicuspids and Molars.—All cases of infraversion in the bicuspid and molar region exhibit as a rule the abnormally deep overbite anteriorly, often with protruded upper incisors, and when this condition occurs in Class I, the anterior malocclusion is often mistaken for Class II. In fact, except for the lack of distal occlusion many of these abnormally deep overbite cases in Class I have all the same structural peculiarities in maldevelopment in the lack of vertical development in the bicuspid and molar region, as well as a corresponding facial inharmony, as cases exhibiting the abnormally deep overbite in Class II. The treatment of these cases in the vertical development in the bicuspid and molar region and in the correction of the occlusal plane and restoration of the normal overbite varies but little in Class I and Class II, except for the mesiodistal change in the treatment of Class II.

The so-called upper protrusions of Class I are so similar to the cases of the first division of Class II in the anterior malocclusion that the differential diagnosis can only be made from an examination of the mesiodistal relationship of the bicuspids and molars. They exhibit the same peculiarities of maldevelopment of the dental arches and of the occlusal plane, and the overbite varies in depth to the same extent.

Case XI.—A case involving infraversion of the bicuspids and molars of Class I, having all the symptoms of the first division of Class II, with the exception of the distal occlusion, is shown in Figs. 835 A and 836, before and after treatment.

The upper incisors were greatly protruded and separated, and the lower incisors were biting deeply into the gums lingual to the upper incisors. The lower left second deciduous molar was prematurely lost, and the consequent diminution in space for the unerupted second bicuspids contracted the lower arch, which also exhibited the greater abnormality in the occlusal plane.

Some of these cases exhibiting lack of vertical development in the bicuspid and molar region with protruded upper incisors and a deep overbite may be treated successfully without other means of opening the bite than the force of the intermaxillary elastics, and in the case shown in Fig. 835, this force continually acting during treatment extruded the molars, and together with the development of the lower arch, restored the proper level of the occlusal plane.

The use of the alignment arches for treatment of the case is very similar to its application in Class II with the intermaxillary elastics stretched from the distal end of the buccal tubes on the lower molar bands to the

hooks on the upper alignment arch as illustrated in the drawing in Fig. 837.

The resistance of the entire lower arch was enlisted by ligating all of the eight anterior teeth to the lower alignment arch, allowing the nuts to

Fig. 835 A.—Case XI. Upper protrusion of Class I involving infraversion of bicuspids and molars.

Fig. 836.—Case XI. After treatment of case shown in Fig. 835.

be tightened occasionally for enlarging the lower arch, and regaining the space for the unerupted second bicuspid.

By allowing the alignment arch to slide distally in the anchor tubes on the upper bands, all of the intermaxillary force was directed against the

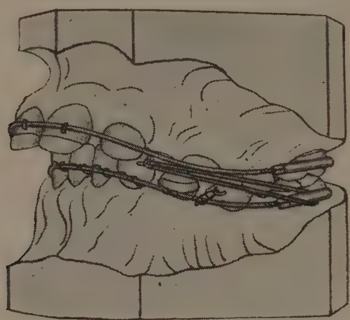


Fig. 837.—Case XI. Treatment by use of labial alignment arches and intermaxillary force.

labial surface of the incisors, and the normal occlusion of the anterior teeth restored.

While the intermaxillary elastics were not applied in this case with the intention of assisting in the vertical development of the bicuspid and the molar region, this effect was produced and the height of the occlusal plane restored to normal as evidenced by the restored normal overbite shown in the after-treatment model in Fig. 836. A more scientific adapta-

tion of the elastics for producing the vertical development is in their triangular attachment as shown in Fig. 790, but the theory of maldevelopment of the occlusal plane in these cases being unknown at the time this case was treated, the triangular use of the intermaxillary elastics had not been developed. Enough force was developed in the vertical plane through the stretching of the elastics when the teeth were not in occlusion to produce the vertical development necessary in the case. The bite plane could also have been used to advantage in this case.

The patient had been a mouth breather in early childhood, but had been operated upon for the removal of adenoids early enough so that through the stimulation to vertical development in the bicuspid and molar region and the restoration of the normal in occlusal relations of the arches of

FIG. 838.—Case XI. Profile of case of neutroclusion simulating distoclusion before treatment.

FIG. 839.—Case XI. Profile of case after treatment.

teeth, the asymmetry of the facial lines was completely overcome, as is evidenced from the photographs of the profile in Figs. 838 and 839.

The asymmetry of the facial lines in this case is so similar to the most severe types of the first division of Class II, that a differential diagnosis cannot be made without a diagnosis of the cusp relationship of the arches of teeth in occlusion.

Lower Protrusions of Class I Simulating Class III.—Among the variations from normal occlusion in Class I is the so-called "lower protrusion," having all of the symptoms of Class III in its malocclusion except the mesio-distal malrelation, which is the main point of difference in the simpler cases. In these cases, the profile presents the same inharmony as in Class

III, and the differential diagnosis has to be made from the malocclusion of the teeth.

The molars and bicuspids are in their normal mesio-distal relation although they may be in bucco- or linguo-version. The apparent protrusion of the lower arch is due entirely to the linguo version of the upper incisors, including sometimes the cuspids. Through lack of anterior development in the upper arch, the upper incisors fail to erupt in their proper labial positions, and even if their lingual inclination on eruption be but slight, the powerful forces of the lingual inclined planes of the lower incisors, acting continuously in occlusion upon the labial inclined planes of the upper incisors, soon force them into such lingual positions that further anterior development of the upper arch is impossible, and it will remain for years in this condition of arrested development. The prognosis in these cases, however, is favorable for treatment at any age, although the best results are obtained during the period of greatest development of the dental arches in childhood.

Likewise, in a study of the facial inharmony in these cases, it will be observed that the region of the upper lip and middle third of the face only is out of balance with the rest of the features, due to the lack of anterior development of the upper arch. The chin, lower lip, nose, and forehead are all in balance, and by developing the middle third of the face through restoration of the upper incisors and cuspids to normal occlusion relations, the balance and harmony of the entire face will be restored, and lines of beauty be substituted for lines of deformity and ugliness.

Case XII.—In Fig. 840 is illustrated a not uncommon case of Class I in which some of the characteristics of Class III are duplicated in the apparent protrusion of the lower arch in the casts on the left.

In a study of the dynamics and anchorage in this case the resistance values must be carefully noted in order that the anchorage may be sufficiently re-enforced to resist the unusual amount of force which must be exerted from the primary first molar anchorage in the upper arch for the labial movement of the upper incisors, each one of which is apparently effectually blocked by the inclined planes of the lower incisors in occlusion. If it were not for the fact that the force of occlusion is not constant, being intermittent through the opening and closing of the mouth, it would be almost impossible to re-enforce the upper first molar anchorage sufficiently to be able to move the upper incisors labially. As it is, if the attempt is made to use the alignment arch on the upper arch to move the upper incisors labially without re-enforcement of the molar anchorage, it will usually be found that the upper molar anchor teeth will not withstand the strain, but will tip distally to such an extent that treatment will have to be discontinued, and the molar anchor teeth allowed

to tip forward and rest for a time before beginning treatment again with a proper re-enforcement of the anchorage.

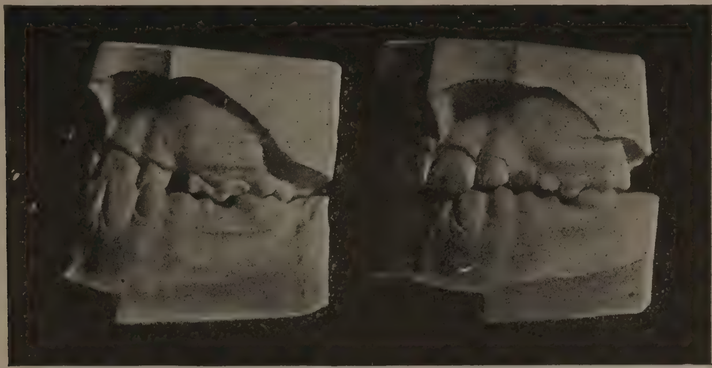


Fig. 840.—Case XII. Neutroclusion simulating mesioclusion anteriorly. Before and after treatment casts.

In the treatment of this case, shown in Fig. 841, the threaded alignment arch was used upon the upper arch, and the incisors moved into

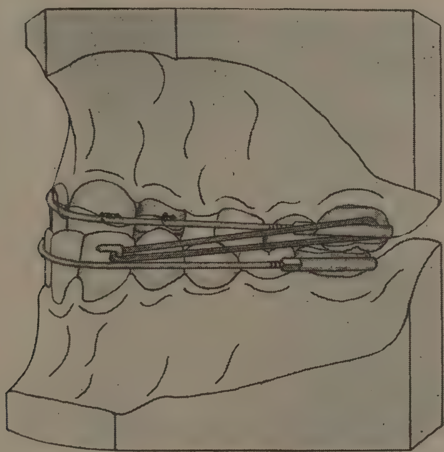


Fig. 841.—Case XII. Treatment with alignment arch on upper, re-enforced by intermaxillary anchorage.

labial occlusal positions by *inclination movement*, through their attachment to the alignment arch with wire ligatures, but the upper molar anchorage was re-enforced by intermaxillary anchorage during the entire treatment of the case. To illustrate the dynamics and anchorage in this case diagrammatically, the drawing in Fig. 842 represents the alignment arches in position with the proper re-enforcement of the upper molar anchorage. The primary resistance of the simple molar anchorage is

represented as 4 units, the resistance of the upper incisors in lingual occlusion 14 units, and a force of 16 units enough to move the upper incisors labially, but the simple molar anchorage resistance is insufficient.

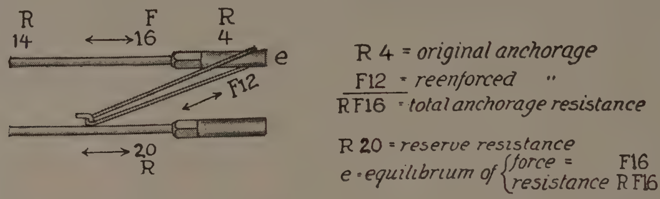


FIG. 842.—Case XII. Diagram of dynamics and anchorage illustrating the necessity of re-enforced anchorage.

The upper molar anchorage resistance is increased to 16 by the addition of 12 units of intermaxillary force. With this re-enforcement of the primary molar anchorage, the 14 units of resistance of the upper incisors

FIG. 843.—Case XII. Profile of neutroclusion simulating mesioclusion.

FIG. 844.—Case XII. Profile of Fig. 843 after treatment.

in linguoversion may be overcome, and their labial movement accomplished. An equilibrium of force and resistance, 16 F vs. 16 RF is thus established in the upper molar anchorage, which is desirable, as the addition of a greater number of force units to the upper molar anchorage

beyond the point of equilibrium would result in the mesial movement of the upper anchor teeth.

The upper lateral incisors were banded and ligatures so directed from lingual spurs on these bands, to spurs on the alignment arch that the spaces for the unerupted cuspids were regained during the labial movement of all of the incisors. Fig. 843 exhibits the profile before treatment of the case and Fig. 844 the profile after treatment.

Case XIII.—In some of the Class I cases simulating Class III, the bodily movement of the upper incisors and cuspids seems to be the rational indicated treatment. A case from the practice of Dr. J. Lowe Young, illustrating the limitations of *inclination movement* and the development of the dental arch by *bodily movement* of the teeth beyond the limitation of *inclination movement* is shown in Fig. 845.

Fig. 845.—Case XIII. Neutroclusion simulating mesioclusion illustrating the limitations of inclination movement and the result of bodily movement of the upper anterior teeth. (*After J. Lowe Young.*)

The model on the left represents the case before treatment, the second model, the case after treatment, with the threaded alignment arch and ligatures using inclination movement. The crowns of the upper incisors and cuspids were considerably inclined labially and their roots seemed to be moved forward but little even after two years of retention and the operation of the forces of occlusion. At this period in the retention of the case, the retaining appliance was removed and the pin and tube arch with attachments for bodily movement of the teeth was placed upon the dental arch. After two and one half year's treatment the beautiful result in development of the anterior part of the dental arches as shown in the third model in Fig. 845 was obtained.

Case XIV.—An adult case (age 18) of linguoversion of the upper incisors and cuspids in Class I, further complicated by the congenital absence of the four upper bicuspids and consequent contraction of the

upper arch is shown in Fig. 846, before and after treatment. This case presents unusual difficulties beyond those encountered in the somewhat similar cases previously described, first, on account of the age of the patient, with the increased resistance to labial movement of the upper incisors and cuspids, and second, because of the great amount of development

FIG. 846.—Case XIV. Neutroclusion simulating mesioclusion with missing upper bicuspids. Age 18. Before and after treatment casts.

necessary to regain the space of the bicuspids, the upper cuspids and molars having drifted toward each other until they were almost in contact as shown in Fig. 846.

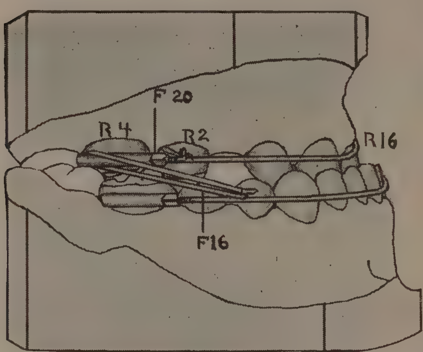


FIG. 847.—Case XIV. Alignment arches used in treatment of case illustrating re-enforced anchorage.

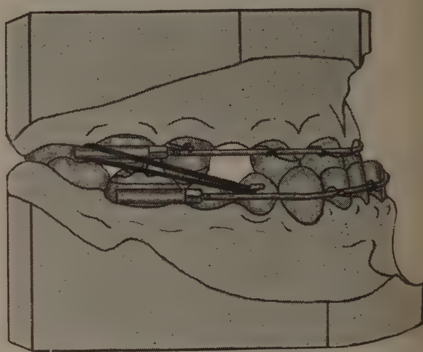


FIG. 848.—Case XIV. Diagram illustrating necessity of re-enforced anchorage.

The upper incisors and cuspids were moved labially by inclination movement, through the use of the threaded alignment arches, and a still greater intermaxillary re-enforcement of the upper molar anchorage was necessary than in the cases shown in Fig. 840. The appliances in position are shown in Fig. 847. The upper cuspids were banded, and moved labially by inclination movement partially at the same time as the upper

incisors and partially independent on their movement through the direction of ligatures attached from lingual spurs on the cuspid bands to spurs on the upper alignment arch during the development of the upper dental arch.

The upper cuspids and first molars were separated considerably before the upper incisors were ligated to the upper alignment arch to lessen the resistance on the upper first molars until the cuspids were fairly under way in their mesial movement, and the upper molars moved into their proper bucco-lingual relations by the lateral spring of the alignment arches. The upper incisors during the process were ligated one at a time to the alignment arch until all four incisors were ligated, when, on account of the increased resistance required by the upper first molars, the intermaxillary force was added as a re-enforcement of the upper molar anchorage.

FIG. 849.—Case XIV. Upper casts of Fig. 846 before and after treatment showing the opening of spaces for the missing bicuspids.

The dynamics and anchorage in this case is numerically shown in Fig. 848, the primary upper molar anchorage resistance being represented by 4 units, the upper cuspid resistance as 2 units, the force of 20 units being sufficient to separate the cuspid and molar on each side, and later to move labially the upper incisors, the resistance of which R16, added to R2, the cuspid resistance, making a total of 18 resistance units to be overcome by 20 force units. The upper molar anchorage resistance, R4, is re-enforced by 16 units of intermaxillary force, F16, drawing from the excess of anchorage resistance of the teeth of the entire lower arch ligated in phalanx.

In spite of the advanced age of the patient, the result in development of the upper arch was nearly all that could be desired, the bicuspid spaces being regained, and the upper incisors and cuspids moved into labial positions as shown in Fig. 849. The change in the facial lines was much more marked than the photographs in Fig. 850 show.

After a few months retention of the case with the intermaxillary force, an upper lingual arch wire being substituted for the labial alignment arch, and a lower lingual arch for the labial alignment arch, and the intermaxil-

Fig. 850.—Case XIV. Profile of case before and after treatment.

lary elastics attached from hooks on the upper molar bands to hooks on the lower cuspid bands, the intermaxillary retention was discontinued.

Fig. 851.—Case XIV. Removable crib retention with artificial bicuspids attached. (*After J. W. Beach.*)

A removable crib appliance, Fig. 851, with artificial substitutes for the missing bicuspids, devised by Dr. J. W. Beach, was then worn in the upper arch as a permanent retaining appliance.

CHAPTER LIII

TREATMENT OF CLASS II. (DISTOCLUSION)

Diagnosis of Class II.—The distinguishing characteristic of Class II in occlusal relations, Fig. 852, is the bilateral or unilateral distal occlusion or distoclusion of the lower arch, the upper arch being narrow with protruding incisors in the first division, and retruded incisors in the second division. The full divisions are in bilateral distoclusion, and the sub-

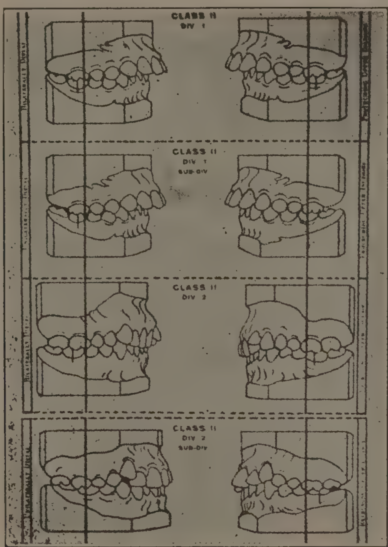


FIG. 852.—Divisions and subdivisions of Class II.

divisions in unilateral distoclusion, the latter exhibiting normal mesiodistal relations in one lateral half.

The facial profile is deficient in contour in such a way as to be indicative of the malocclusion, the chin and lower lip receding, and the upper lip short and exhibiting the protruding upper teeth in the first division of this class, as illustrated in Fig. 874. In the second division, a marked recession of both upper and lower lips and chin is noticeable, as in Fig. 918.

The habit of mouth-breathing, and the open and drooping mouth, the short upper lip, the receding chin and the facial expression, are peculiarly diagnostic of the first division of Class II, although it is sometimes difficult to distinguish it from the mouth-breather of Class I by observance of the facial inharmony alone.

Etiological Factors.—The study of the possible etiology of the particular malocclusion exhibited in Class II cases is important to the diagnostician, as upon his ability to recognize the chief developmental insufficiencies present in these conditions rests his success or failure in their treatment.

Following back the history of this class of cases to a possible period when certain arrested developmental conditions were inaugurated, it may be assumed that, consecutively, arrest of development first occurred in one or both of the dental arches, and secondly, the later growth of the dental arches was along the abnormal lines established by the arrested growth, and influenced by the consequent malocclusion of the inclined cusp planes, and in many cases by the habit of mouth-breathing, with its abnormal tension of muscles.

In a careful study of these conditions it will be observed that there is a predisposition to this malformation of the dental arches and the distoclusion in these cases long before the eruption of the permanent teeth to occlusion.

In fact, the existence of distoclusion of the deciduous arches establishes the claim that certain persistent factors other than any cusp influence must have been pre-operative in causing these conditions in the deciduous

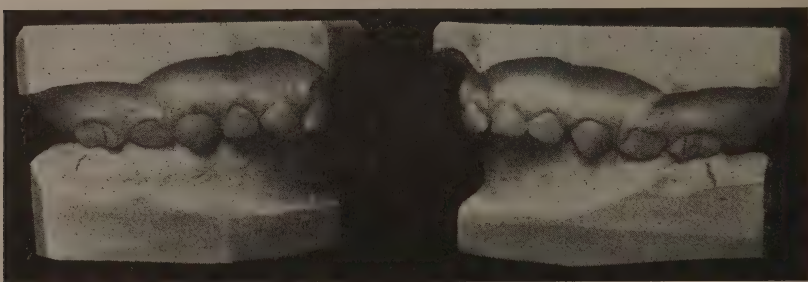


FIG. 853.—Distoclusion of deciduous arches at two and a half years of age.

arches. That distoclusion is not uncommon among children of less than six years of age is a fact which the model collections of the specialist in orthodontia can easily verify.

Figs. 853 and 854 illustrate the distoclusion and facial profile of a child two years and ten months old. Not only is the distoclusion of considerable extent, but the facial inharmony is easily noticeable at this age.

Treatment of these conditions of distoclusion in the deciduous arches is established upon the same basis of restoration of normal occlusion and development as with the dental arches which contain at least the four permanent molars of the second dentition.

It is the author's opinion that the large majority of cases of distoclusion may be observed during the retention of the deciduous teeth, whether the

impress of arrested function and growth is made upon the developing structures of the maxilla and mandible in this period or an earlier one.

It is possible that holding the mouth open in mouth-breathing gives the mandible its distal pose in these cases, and it is certain that in those cases of Class II, Div. 1, having the shortened upper lip, the abnormal tension of the muscles is an etiological factor in the narrowing of the upper arch, which latter is, of itself, an effectual barrier to a forward pose of the mandible.

FIG. 854.—Profile of child with distoclusion. Age 2½ years.

A close analysis of the fundamental pathologic conditions which are observed in distoclusion reveals the following malrelationships, each requiring treatment, if present, in order to establish normal relations of occlusion, and normal facial lines.

1. Malrelation of the dental arches.
   (a) Bilateral distoclusion.
   (b) Unilateral distoclusion.
2. Maldevelopment of the dental arches.
   (a) Narrow dental arches.
   (b) Protruded or retruded upper anterior teeth.
   (c) Shallow or deep ovbertie.
   (d) Abnormal occlusal plane.
   (e) Abnormal vertical development.
      (1) Infraversion in bicuspid and molar region,
      (2) Supraversion in incisor region.
      (3) Possible infraversion in incisor region.
3. Malposition of individual teeth.
   (a) Labioversion, linguoversion, torsiversion, infraversion, *et al.*
4. Malformation of individual teeth, supernumeraries, *et al.*

These malrelationships are named in a logical diagnostic sequence and not in the order of their consecutive treatment.

Malpositions of the teeth, in general, as has been previously stated, are but objective symptoms of abnormal development of the dental arches, and to go a step farther, the maldevelopment of the dental arches in any class of malocclusion, as well as in distoclusion, is often symptomatic of a deeper underlying *constitutional* rather than a *local* cause.

So-called local causes, such as adenoids, enlarged tonsils, mouth breathing, thumb sucking, and the like, while they have their influence in the malformation of the dental arches in distoclusion, yet each one has a deeper underlying constitutional cause to account for its own expression.

Some defective development along the respiratory tract, such as a narrow nasal passage due to some obscure developmental deficiency, may be the cause of the lack of full respiration, of adenoids, and mouth-breathing. Likewise, some nervous reaction is the cause of thumb or finger sucking, or like habit, which may have a causative influence in distoclusion.

It must, therefore, be assumed that the causes of distoclusion are largely constitutional and not local, that the narrow dental arches, the narrow middle third of the face, the adenoids and other respiratory obstructions are still only symptoms of deeper underlying and more obscure constitutional causes.

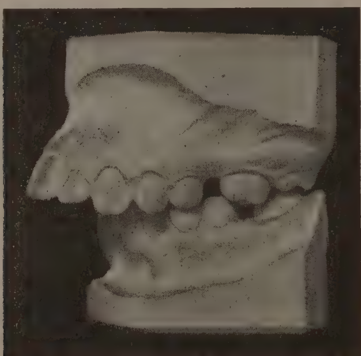


FIG. 855.—Complex case of distoclusion.

FIG. 856.—Profile of patient having the distoclusion shown in Fig. 855.

To illustrate these points, let us observe an extreme case of distoclusion mutilated by extraction, the model shown in Fig. 855, and the profile in Fig. 856. The photo, Fig. 855, of the patient possessing this distoclusion is illustrative of the effect on the whole body of the same causative factor responsible for the distoclusion, for the faulty respiration and for the lack of chest development, which are associated pathologic conditions in the case.

Biologic Interpretations of Phenomena of Distoclusion.—The orthodontic problem, as recognized by the advanced student of orthodontia, is a problem of biology, and in the light of our present knowledge of the subject, no phase of orthodontia, such as the treatment of distoclusion, can be studied without attempting to translate or interpret the biologic phenomena concerned with causative factors, and to speculate as to their results on treatment and the stimulation to development of the dental arches.

Among the chief biologic factors in distoclusion is that of heredity, the import of which has always been confusing because of the difficulty of separating it from other causative factors, nevertheless it is a factor which must be reckoned with. "Heredity is today the central problem in biology," and it is as impossible to ignore it in the study of orthodontic problems as it is to ignore the laws of gravitation, and fearlessly walk out in a shower of hailstones and expect not to be hit.

Conklin says, "Whenever the differential cause of a character (resembling a parent) is a germinal one the character is, by definition, inherited; on the other hand, whenever this differential cause is environmental the character is not inherited."

Let us observe what Conklin has to say on resemblances and differences between parents and offspring with the possibility of determining hereditary character: "On the other hand resemblances and differences between parents and offspring are not due to heredity at all, but to environmental conditions. By means of experiments it is possible to distinguish between hereditary and environmental resemblances and differences, but *among men where experiments are out of the question generally it is often difficult or impossible to make the distinction.*"

Assuming that there are certain cases of distoclusion of hereditary origin recognizable simply from macroscopic observation in spite of what authorities on biology have to say on the subject, it is not possible to be certain of such a diagnosis of an hereditary cause of distoclusion at the early age when distoclusions present and should be treated.

Granting, however, that a certain distoclusion of early childhood was suspected to be of hereditary origin and it seemed advisable to wait until the eruption of the permanent teeth to decide this question in order to carry out the principle of extraction, as suggested by Dr. Case, of two upper first bicuspids in a Class II, Div. 1 case for example, and retruding the protruding upper incisors and canines, *one would have to allow the dental arches to remain in their undeveloped and malrelated condition until the eruption of the bicuspids or until about eleven years of age before beginning treatment, losing those preceding years of childhood when natural growth*

might aid most in developing the dental arches under proper artificial stimulation by orthodontic means.

Again, the weakened and deficient muscular function in these cases would also have to await the age of eruption of the bicuspids allowing an intervening growing period of childhood to elapse which might have been to its greatest advantage in strengthening and developing these undeveloped muscles by proper exercise.

CHAPTER LIV

TREATMENT OF CLASS II, DIV I. (DISTOCLUSION)

Diagnosis.—The chief diagnostic symptoms of the first division of Class II consist in the bilateral distoclusion of the lower dental arch, the retrusion of the mandible, and protrusion of the upper incisors as diagrammatically shown in Fig. 852. The dental arches are usually narrow, and the overbite deep or shallow, depending upon the existence of a greater or less degree of infraversion in the bicuspid and molar region.

The upper lip is usually short, the mouth drooping open as a result of mouth-breathing, and the muscles of the jaws weak and on an abnormal tension.

Examination for Mouth-breathing and Respiratory Obstructions.—Inasmuch as mouth-breathing is so commonly co-existent with Class II, Div. 1, its diagnosis in any case should be followed by an examination of the nasal and pharyngeal passages by a competent rhinologist, and the removal of respiratory obstruction if found.

Advisability of Early Treatment of Distoclusion.—It is of special importance that the treatment of Class II cases should be begun at an early age in order to take advantage of a normal growth period during and after the correction of the malocclusion, the stimulation to normal development through treatment assisting materially in the permanent retention of the normal occlusal relations. Cases may be begun before the eruption of the first permanent molars, but the author has had better results in beginning them just after the eruption of these teeth.

Constitutional Treatment in Distoclusion.—Inasmuch as the symptomatology of distoclusion reveals disturbances of a systemic as well as a local nature, the treatment of these cases should be *constitutional* as well as *local*. Recognizing the constitutional disturbances as the most serious cause of the maldevelopment of the dental arches as well as of the body as a whole, a thorough physical examination of the child should be made and proper therapeutic procedure instituted according to the needs of the individual case.

For example, if the respiratory system is faulty, the respiratory channels blocked by adenoids or diseased tonsils should be freed by operation, and proper breathing and physical culture exercises given for chest development.

If the child with distoclusion exhibits malnutrition, special diets should be instituted for building up the system to a normal vital standard. If the

patient is lacking in the thyroid or pituitary stimulation to growth, the prescripting of extracts of these glands may have a possible beneficial effect.

Maldevelopment of the body as a whole from unknown causes will have to receive the proper attention at the hands of the experienced physician, although it may be difficult to get any results from experimental treatment.

Hereditary influences have already been discussed, and although in adult cases the possible stamp of heredity is confirmed beyond all possibility of change by growth processes, in suspected cases of hereditary origin in childhood, decided improvement in growth processes and in restoration of occlusion without extraction and improvement in facial lines is possible. It is probable, of course, that a case may be partly of hereditary and partly of some other etiologic origin which might account for the great improvement in these cases when the supposedly insurmountable stamp of heredity is present.

Treatment of Weakened Musculature.—Most of the severe cases of distoclusion, of Class II, first division, Angle's classification, exhibit such lack of development of chest muscles as well as the muscles connected with the jaws that general posture exercises should be instituted in the treatment, and also the special exercises advocated by Dr. A. P. Rogers for developing the weakened and deficient muscles of the jaws such as are described in the chapter on muscle training.

Some cases of distoclusion have been treated successfully by Dr. Rogers by means of these exercises alone as he has shown. The papers by this writer on the subject have given the greatest impetus and encouragement in the treatment of distoclusion of any recently propounded therapeutic auxiliary in these seriously deformed cases.

Habits and Their Treatment.—Habits of lip biting, thumb, finger and tongue sucking require special counteractive remedial agencies, mechanical and psychological.

Protruding points on orthodontic appliances which will cause interference with the lips in biting may have some deterrent effect in the lip-biting habit, and the wearing of aluminum mittens will help to cure the thumb-sucking habits, unless the patient is too old to wear them, when it is too late to use mechanical deterrents. In these cases every effort should be made to increase the patient's will power to overcome the habit. The power of auto-suggestion is very valuable and is often sufficient to effect a cure of these harmful habits. The substitution of other unharmful habits is a sound psychologic principle and may be used to advantage in some of the habit cases.

Rationale of Early Treatment of Distoclusion.—There seems to be a considerable difference of opinion among orthodontists as to the proper age to treat distoclusion, some advocating the early treatment of the distoclu-

sion in the deciduous arches. One might not find any advantage to accrue in beginning the treatment thus early, as occasionally the distoclusion reappeared later in the "mixed denture," with possibly a deep overbite as well. However, when one considers the possibilities of directing the developing jaws toward their normal relationship by orthodontic means,

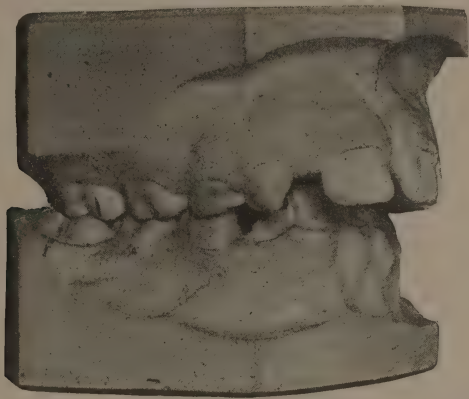


FIG. 857.—Case I. Complex case of distoclusion. Age 7 years.

and the strengthening of weakened muscles of the jaws and face at this early age, it is impossible to disregard this early treatment as of no avail.

Again, for the same reason it seems consistent to treat distoclusion of the "mixed dentures" before the loosening of the deciduous molars, using

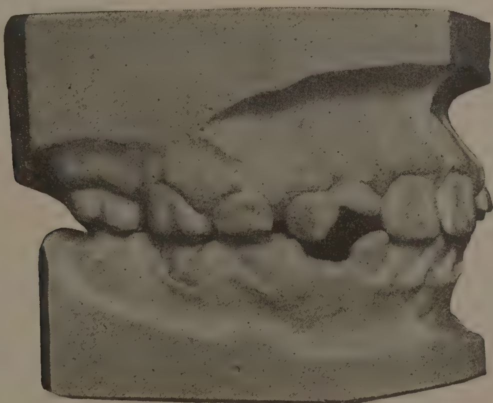


FIG. 858.—Case I. Restoration of arch sizes and forms, and correction of deep overbite and of distoclusion in case shown in Fig. 857.

the first permanent molars for anchor teeth for appliances to develop the dental arches, and to shift the occlusion and change the deep overbite when present in these cases.

Case I.—To illustrate the value of such early treatment of distoclusion, even in cases of suspected hereditary origin, the writer has selected a case of distoclusion of the age of seven years, Fig. 857, the origin of which

seemed clearly of an hereditary nature, and in Fig. 859 is exhibited the degree, of development obtained up to the time of retention.

Thus, in the stages of treatment of this distoclusion case, the treatment was carried out according to the idea of growth stimulation during

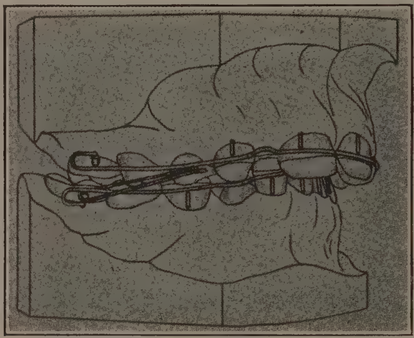


FIG. 859.—Case I. Pin and tube appliances for bodily movement supplemented by intermaxillary force.

the growth period of childhood, the dental arches being developed and the occlusion shifted to normal, and retained until the eruption of the cuspids, bicuspids, and second molars, at the same time strengthening the weakened

FIG. 860.—Case I. Profile before treatment. Case I. Profile after treatment.

facial muscles by the intermaxillary forces applied. The Hawley chart for a .39 incisor indicated a great deal of lateral development of both dental arches. The indications for bodily movements of the teeth require the use of the pin and tube appliances on both upper and lower dental arches with the additional use of intermaxillary force as shown in Fig. 859.

The beneficial effects in obtaining more esthetic relations in the profile and eliminating abnormal facial lines is very marked as shown in the contrast between the before and after treatment photographs in Fig. 860.

At the same time also, in this case, blocked respiratory channels in the nose and throat were freed by rhinological operation, and although this case was treated some years ago before exercises for weakened muscles were deemed necessary, the facial lines after treatment are sufficient answer to the question of advisability of early treatment, even in cases of suspected hereditary origin. Nor would it seem advisable to wait until the eruption of the permanent teeth to be certain of a diagnosis of hereditary origin before beginning orthodontic treatment with the wonderful possibilities of growth of the dental arches under such treatment, and the restoration of lines of beauty to the face.

Thus the problem of distoclusion, even with possible hereditary factors present may be one of associated maldevelopment of the dental arches due to a lack of sufficient stimulus to growth and *the most beneficial local therapeutic agencies are those which supply that stimulus during the growing period of childhood.*

Hence, the "*biomechanical*" processes of growth stimulation to the maldeveloped dental arches in distoclusion are the main reliance of those orthodontists who believe in the possibilities of thus assisting the dental arches to grow out of their malrelationship until proper and sufficient function shall have been established to retain the normal relations of occlusion which may have been obtained.

Distinguishing between Treatment of Children's and Adult Cases of Distoclusion.—In accordance with the previously described reasons for the early treatment of distoclusion it is necessary to distinguish sharply between the treatment of distoclusion of children from seven to fourteen years, and of the adults beyond the age of fourteen in whose mouths the dental arches are so nearly fully grown in their malocclusal relations that artificial stimuli to growth is much less liable to produce successful results, and the necessity for improvement of the facial lines by another method than dental arch development and a mesio-distal change in occlusion may have to be considered.

Classification of Treatment of Class II, Div. 1.—For the sake of clarity and a better understanding of the different phases of treatment of distoclusion, the author has divided the forms of distoclusion into three classes which range from the simplest to those having the most extreme complications, and has designated them as *simple*, *compound* and *complex*.

Simple cases represent those cases of distoclusion which require the use of appliances for restoring the proper form and size of the dental arches

without the further use of appliances to make the mesiodistal change in occlusion.

Compound cases require appliances both for the establishment of normal arch form and size, and for the mesiodistal change in occlusion.

Complex cases include all of those more complicated cases which require, in addition to restoration of normal arch form and size and a mesiodistal

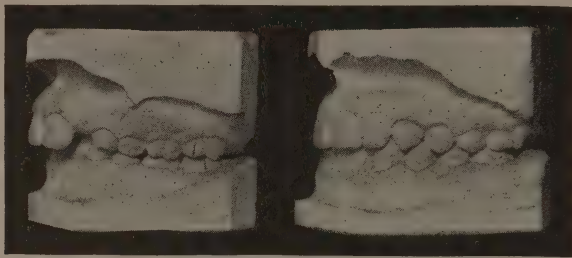


FIG. 861.—Case II. A simple case of distoclusion. Left side.

change in occlusion, such special treatment for the correction of the abnormal overbite, abnormal occlusal plane and various other abnormalities as are not included under the simple and compound cases.

Technique of Local Treatment of Simple Cases of Distoclusion.—The local treatment of distoclusion refers especially to growth-stimulating by the use of appliances for the development of normal arch form, normal

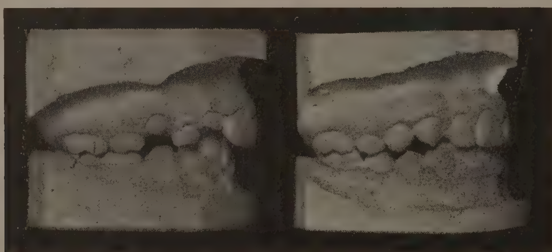


FIG. 862.—Case II. Right side of case shown in Fig. 86.

arch relationship, and the correction of individual tooth malpositions, establishing the normal function of the teeth in occlusion.

The forces applied for this purpose in early childhood should be stimulative to growth rather than excessive in amount and the appliances should be delicate and inconspicuous, and applied so that they interfere the least with speech, mastication, or the natural prophylactic functions in the oral cavity.

In the simple cases of distoclusion either of the first or second division with a normal overbite, the establishment of the proper size and form of each dental arch by development, and the correction of the malposition of individual teeth, especially the cuspids and first molars, will occasionally

be all that is necessary to unlock, as it were, the slightly retruded lower dental arch so that it can move forward of its own volition without the use of a mesiodistal force. Figs. 861 and 862 illustrate such a simple case of distoclusion, requiring simply the development of the dental arches, especially in the upper cuspid region, so that the lower dental arch could assume its proper forward pose without mechanical hindrance. Fig. 863 exhibits a lingual arch on the upper dental arch of such a case for anterior

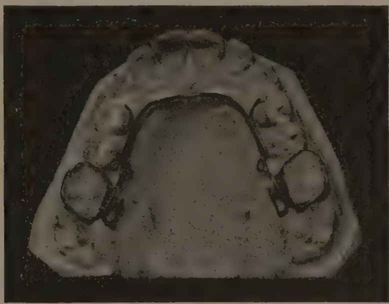


FIG. 863.—Widening anterior portion of upper arch in a simple distoclusion case with lingual arch.

development to unlock the distal occlusion of the lower cuspids. Often the rotation of lingually rotated first molars, above or below, will be found to be the particularly necessary tooth movement required to establish the normal relationship of the dental arches and allow the lower arch to to move forward to normal mesiodistal relations.

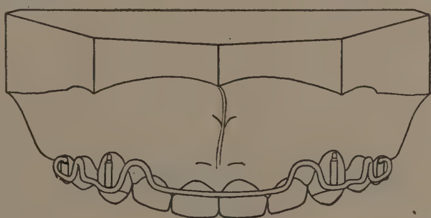


FIG. 864.—Junior pin and tube appliance for developing the deciduous dental arch. (*Dr. J. Lowe Young.*)

Again the development of the anterior part of the dental arches so that the cuspids above and below can find their occlusion will be found to be the special tooth movement to accomplish in order to establish the mesiodistal change. The delicate .030″ alignment arch on the upper dental arch attached to the molar bands by either horizontal or vertical tubes, and to the deciduous cuspid bands by the pin and tube attachment as shown in Fig. 864, very efficiently controls the development of the arch and the relation of the molars in these simple cases of distoclusion. The appliance in the latter illustration is a pin and tube appliance designed by Dr. J. Lowe Young. This appliance can be constructed with loops, so

that the desired amount of anterior development can be obtained by straightening out the loops.

In the simple cases the lower dental arch is held distal of its normal mesiodistal position by the narrow upper arch, which when widened, unless the first molars are rotated or other malpositions of the teeth interfere, allows the lower dental arch to move forward into a normal and more comfortable position with the normal cusp relationship established.

Fig. 755 exhibits the use of the lingual arch for developing the upper dental arch anteriorly so that the lower arch can move forward to normal occlusal relations with the upper arch.

The simple cases of distoclusion of either the first or second division are amenable to treatment by the use of various appliances for dental arch development from the plain alignment wire to the ribbon arch applied labiobuccally, or the lingual arch wire, in its various forms. As a prophylactic measure, whenever it is possible to use the lingual arch in the simple cases, the labial and buccal surfaces of the teeth are kept free from appliances, and there is much less chance for the accumulation of food particles on the teeth or appliance as in the case of the labial wires.

In the treatment of the simple cases of distoclusion, the exercises for weakened jaw muscles should be instituted just the same as in the more extreme cases of distoclusion as a matter of precaution by strengthening these muscles in their normal pose. *Bodily movement* of the teeth in distoclusion, while of greater importance in the complex and compound cases, should be taken advantage of when indicated in *simple cases* also by the use of the various forms of stationary buccal or lingual attachments. In the movement of teeth other than anchor teeth with the lingual arch wire, nature's own forces of tongue and lip pressure and the interstitial building up of the osseous structures supporting the teeth, aided by the gentle stimulation of the lingual arch and the restoration of function, will be found sufficient for proper arch development without the use of special attachments for bodily movement.

Treatment of Compound Cases of Distoclusion.—Compoun dcases of distoclusion require a *mesiodistal force* in addition to the treatment accorded simple cases in arch development and correction of malposition of individual teeth in order to establish the mesiodistal change, there being no further complication such as the excessive overbite, etc., to consider.

As in the simple cases of distoclusion, the dental arches should be developed to some extent before the application of force to make the mesiodistal change, and yet the use of intermaxillary force for this purpose should not be delayed too long. The development of the upper arch should be carried along until the lower dental arch is free from any influence in its

forward movement, especially in the anterior part of the upper arch, before the intermaxillary elastics are applied.

Intermaxillary force and anchorage is secured by the attachment of the rubbers from the hooks on the upper alignment arch to the ends of

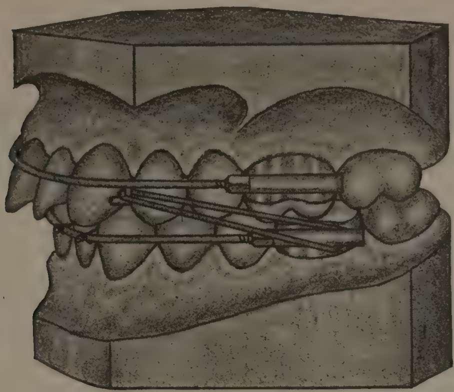


FIG. 865.—Alignment arches and intermaxillary force for the treatment of compound cases of distoclusion.

the tubes on the lower alignment arch, as illustrated in Fig. 865. In adult compound cases of this class the first permanent molars may be used for attachment of anchor bands in cases in which the second molars are erupted, since the intermaxillary force can be made strong enough to

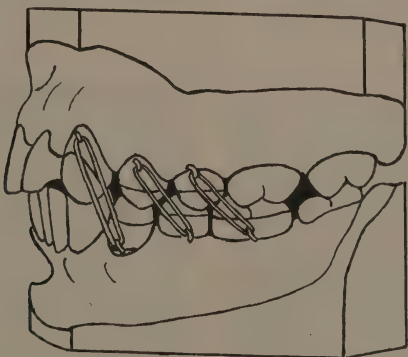


FIG. 866.—Use of intermaxillary force on individual teeth in distoclusion. (*After Casto.*)

move the lower arch forward with this anchorage.

It may be necessary in the treatment of mixed dentures in which there is much anterior development needed in the lower dental arch, and in which the second permanent molars are unerupted, to apply a light intermaxillary force at first as a re-enforcement of the lower molar anchorage, and later with force enough to shift the occlusion.

After the lower arch has been partially shifted forward, the lower alignment arch may be removed and a lingual arch attached to the molar

anchor bands, which are provided with hooks in place of the buccal tubes. The lingual arch acts as a working retainer and the lower anterior teeth can be more easily kept clean during the long period of treatment.

In shifting the occlusion from distal to normal in some cases in which the permanent teeth are nearly all erupted, it will be found that although the molars may respond readily to the intermaxillary force, the cuspids

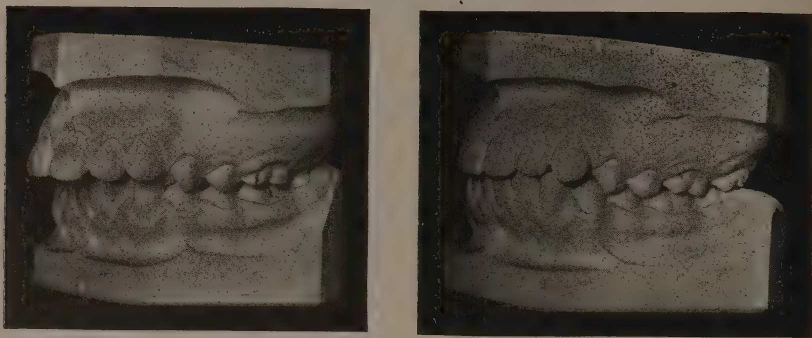


FIG. 867.—Case III. Compound case of distoclusion before and after treatment. Left side.

and bicuspids, especially in the upper arch, may not be so easily moved in the desired directions through the application of the elastics from the hooks upon the upper alignment arch to the distal ends of tubes on lower molar anchor bands. In these cases, Dr. Casto has suggested the use of intermaxillary elastics between individual banded teeth of the upper and lower arch to overcome the difficulty, as in Fig. 866.

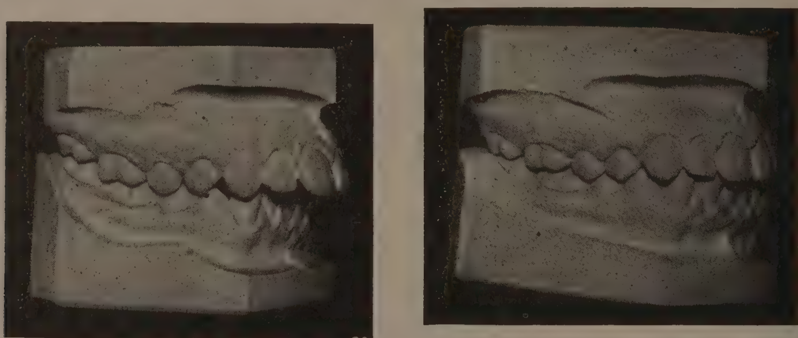


FIG. 868.—Case III. Compound case of distoclusion before and after treatment. Right side.

Case III.—Figs. 867 and 868 exhibit a compound case of distoclusion before and after treatment in which the restoration of arch form and mesio-distal change in occlusion constituted the main features of treatment, the overbite being normal. The appliances used in treatment in this case were the plain threaded alignment wires fitted into horizontal buccal tubes on molar bands (Fig. 869), the anterior teeth being ligated to the alignment

wires until arch size and form in both upper and lower arches was restored. The width of the arches should be retained at this time by lingual retainers which allow of more or less mobility to the teeth. Intermaxillary force may be applied before the restoration of arch form but it usually displaces ligatures and retards the treatment. Preferably, the form and size of each arch should be restored first, and retained, and then the upper alignment wire placed in position with intermaxillary elastics applied from hooks on the upper alignment wire to buccal hooks on the lower molar bands as in Fig. 870 and this treatment continued until the occlusion has been shifted to normal. Such a combination of labial and lingual arch wires, combined with intermaxillary force conforms better to the mechanical, esthetic and prophylactic requirements of today, in cases in which

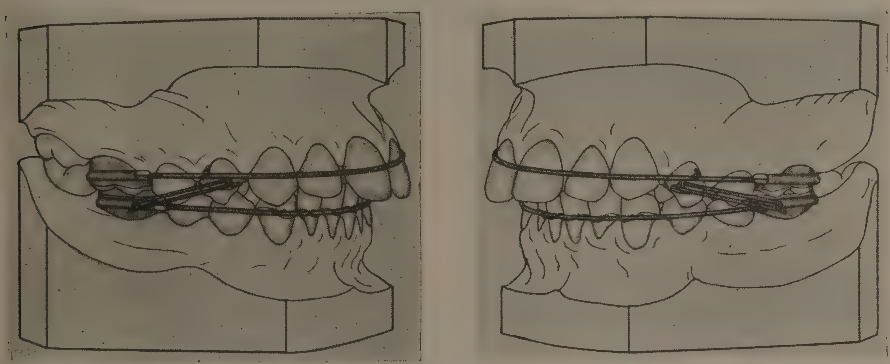


FIG. 869.—Case III. Use of alignment arches and intermaxillary force in compound case of distoclusion.

inclination movement only is necessary, than the use of more complicated appliances requiring the use of a multiplicity of individual tooth bands.

For many years the plain threaded alignment arch wires have been used in these cases for the establishment of normal arch form, to correct the malpositions of individual teeth, correct inclination of incisors, and, through the auxiliary use of *intermaxillary force*, to correct the mesiodistal malrelation of the arches. In spite of the many improvements in appliance construction, the plain threaded alignment arch wire oftentimes will enable one to control all of the teeth of both arches, with a greater degree of mobility of individual teeth, than some of the improvements on this form of appliance. Especially is the application of the plain alignment arch useful on the upper arch after proper arch form has been attained and lingually retained, the labial alignment wire being free from ligatures to individual teeth, the application of intermaxillary force thus allowing of a change in position of the horizontal alignment of the arch wire, thereby aiding in prophylaxis.

The writer has found it to be especially advantageous to use a rather heavy gauge alignment wire for the anchorage support of the intermaxillary force, in producing the mesiodistal change, as in Fig. 869. In most of these compound cases uncomplicated by multiple tooth malpositions very few ligatures are required upon the upper anterior teeth in reducing the inclination of the incisors in the first division of Class II.

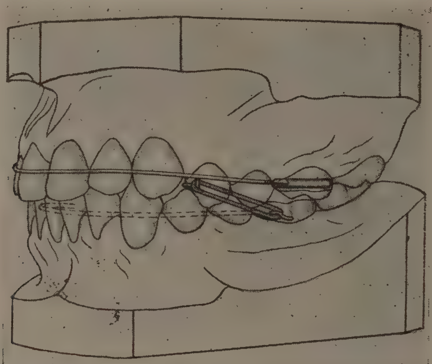


FIG. 870.—Case III. Combination of heavy alignment arch on upper teeth, lingual arch on lower teeth, and intermaxillary force in a compound case of distoclusion.

Combined with this upper labial alignment arch is a lower lingual arch wire varying from the fixed or removable form of pinched wire arch to the removable lingual arches with auxiliary springs for expansion.

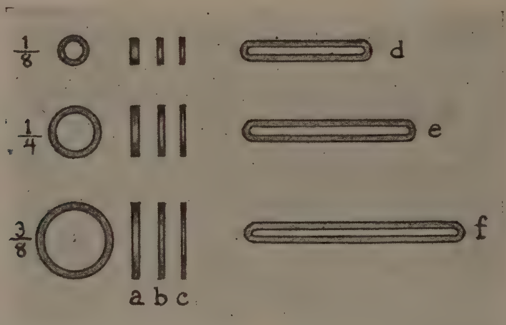


FIG. 871.—Graded sizes of intermaxillary rubbers cut from three sizes of tubing.

Intermaxillary Force.—The intermaxillary elastics should be gauged according to the degree of force required, beginning with light elastics, increasing to heavier, and ending at retention with the lightest elastic that will retain the mesiodistal change. The combination of appliances shown in Fig. 870 may be worn for retention, the upper labial alignment arch being finally worn only at night with verylight elastics before completion of the case.

The chief force in effecting the mesiodistal change in distoclusion is the intermaxillary force produced by the use of elastic rubber rings preferably cut from new Para black rubber tubing. The writer has found that better

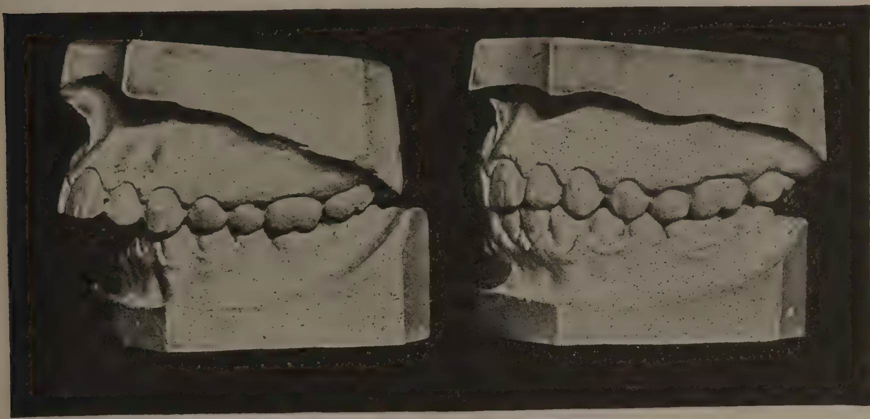


FIG. 872.—Case IV. Compound case of distoclusion before and after treatment. (Left side.)

results are obtainable from having a series of graded sizes of these rubber rings cut from three sizes of tubing, Fig. 871, each size or tubing being cut

FIG. 873.—Case IV. Compound case of distoclusion before and after treatment. (Right side.)

into rings of three different sizes, *a*, *b*, *c*, and marked thin, medium and thick.

The thin size, *c*, of the large diameter tubing ⅜ inch internal diameter should be used at first, until the patient gets used to the tension, the

medium size, *b*, next, and the thick size *a* next, thus increasing the tension by degrees instead of beginning with the maximum force.

The next size smaller ring, ¼ inch internal diameter, may be used in the same manner in many cases, especially where the hooks on upper alignment arches and lower molar bands are not far apart. A record should be kept of each change of size of the rubber rings, so that there may be continuous progress in the case from the use of the minimum to the maximum force.

Case IV.—A very typical compound case of Class II, Div. 1, is illustrated in Figs. 872 and 873, the before-treatment models on the left exhibiting full distal occlusion of the lower arch, and the protrusion of the central incisors in the upper arch. The malocclusion is accompanied by all the displeasing and inharmonious facial lines of the mouth-breather as seen in the short upper lip, and the rolling of the lower lip under the upper incisors, illustrated in front and profile pictures of the case before treatment in Fig. 874.

The alignment arches were adjusted to both upper and lower dental arches in a manner similar to the adjustment in Fig. 869, ligating the teeth anteriorly and laterally, and enough lateral spring was given to the upper alignment arch to effect the widening of the upper arch and retruding of the upper incisors.

The treatment of the case was complicated by the loss of the lower right first permanent molar, and it was necessary to regain this lost space by banding the lower right second bicuspid, and ligating it to the lower alignment arch by a spur soldered a little in advance of this tooth, and turning up the nut on the alignment arch until normal occlusal relations were established, the intermaxillary force on this side being made strong enough by doubling the elastics to resist too great a distal movement of the second molar.

The models on the right of Figs. 872 and 873 illustrate the very perfect occlusal relations which were established, and the pictures on the right of Fig. 874 exhibit the improvement in the profile as the result of treatment.

In describing first the use of the plain alignment arch wires for the treatment of distoclusion, the author does not wish to indicate that they are the best appliances for use in these cases, for there have been many improvements in the form, size and adaptation of these appliances, most of which are excellent, although some of them are complicated enough so that their efficient use in distoclusion cases is beyond the skill of those operators who have not thoroughly mastered the technique of these newer appliances. It might be further stated that the newer appliances are more useful and efficient in that they facilitate progress in treatment in certain cases by providing bodily movement of teeth when indicated, although not allowing of better prophylactic conditions in the mouth.

FIG. 874.—Case IV. Profiles and front faces of distoclusion case before and after treatment.

Case V.—Fig. 875 exhibits a compound case of distoclusion in which there is considerable labial inclination of the upper incisors associated with narrow dental arches, a shallow overbite, and a bilateral distoclusion. Fig. 876 illustrates the use of Dr. Lourie's high labial arch wire to reduce

Fig. 875.—Case V. Casts of a compound case of distoclusion before and after treatment.

the inclination of the incisors in this compound case of distoclusion, and is an ideal inconspicuous appliance for this purpose. At the same time the intermaxillary elastics are attached for shifting the occlusion of the lower arch.

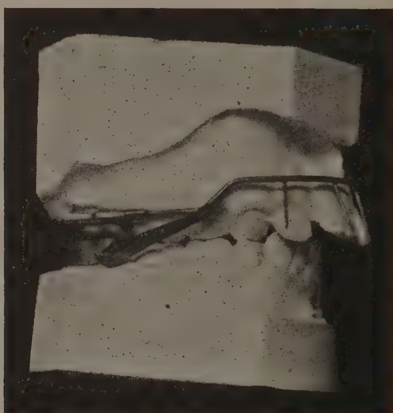


Fig. 876.—Case V. Use of high labial arch with finger springs combined with intermaxillary force.

The removable lingual arch with the auxiliary springs may be used at the same time to develop the upper arch laterally as shown on the upper cast in Fig. 877. The removable lingual pinched wire arch is here seen as the only lower appliance necessary.

In certain of the compound cases of distoclusion where the dental arches are very narrow and where there is considerable inclination of the incisors, bodily movement of the teeth is indicated. Fig. 859 illustrates the use of the pin and tube appliance with half round tube locks on the molar bands for treatment of a case of bilateral compound distoclusion in

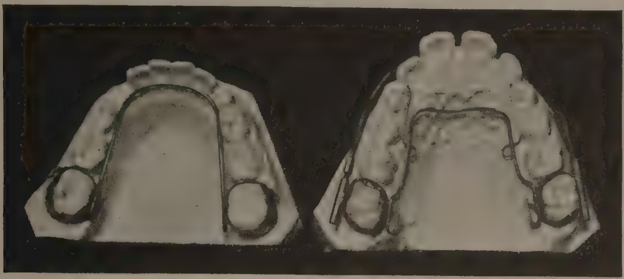


FIG. 877.—Case V. Removable pinched lingual arch on lower. Lingual arch with auxiliary springs on upper arch.

connection with the use of intermaxillary force. Although the pin and tube appliance has fallen somewhat into disuse of late on account of its interfering to some degree with the mobility of the teeth, yet in a simple

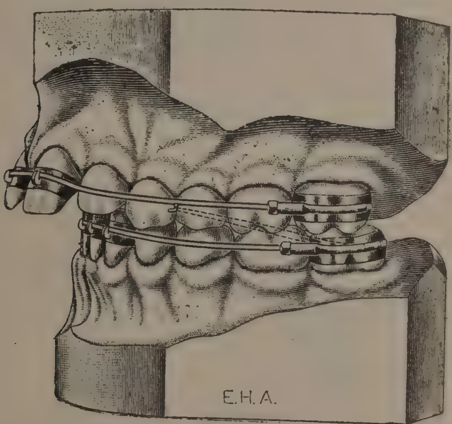


FIG. 878.—Case V. Use of Angle ribbon arches in compound case of distoclusion.

form, with the least number of incisor bands, it is useful, and should not be thrown into the discard inadvisedly.

The ribbon arch, which has superceded the pin and tube appliance, also admirably answers all of the requirements for an appliance for bodily movement when indicated in distoclusion.

Fig. 878 illustrates its application on both upper and lower dental arches in a bilateral compound distoclusion case with protruding upper incisors.

Treatment of Complex Cases of Class II, Div. 1.—Complex cases of distoclusion are complicated to the extent of requiring treatment of the abnormal overbite and abnormal occlusal plane. In addition, therefore, to the treatment necessary for a compound case of distoclusion, special treatment in a complex case must be instituted for the control of the deep overbite, for possible supraversion of the anterior teeth, or for the control of any abnormality of the occlusal plane, especially in the establishment of the vertical development in the molar region where infra version is in evidence.

Special Treatment of the Deep Overbite.—In the majority of cases of Class II, Div. 1, the persistence of the deep overbite is such an obstacle to the attainment of normal occlusal relations that especial adjunct appliances should be utilized for the correction of the deep overbite, or the development of the proper curve of the occlusal plane.

There have been three methods in use for this purpose, one by the use alone of an auxiliary inclined plane lingual to the upper incisors, or in connection with scientifically applied intermaxillary force, another by the building up of occlusal surfaces of the deciduous molars by crowns or onlays to open the bite, and third, by the use of the alignment arch as a double lever in extruding the bicuspids and intruding the incisors in one or the other of the dental arches. The latter method, however, is not adaptable to the "mixed denture" being especially applicable to the permanent denture, as will be later illustrated.

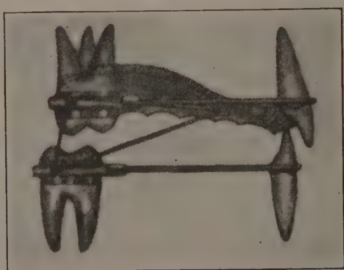
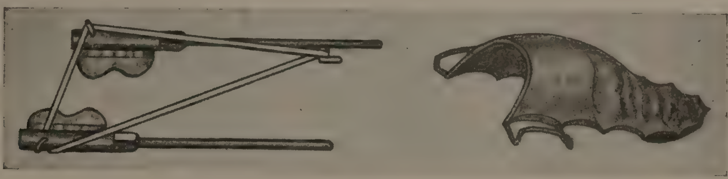


FIG. 878.—Roofplate with inclined plane used with labial alignment arches and intermaxillary force for vertical development.

Without going into the history of the use of the inclined plane, several of the latest improvements or modifications of it in connection with the treatment of the deep overbite in Class II, Div. 1 of distoclusion will be described.

The rubber roofplate, Fig. 879, with an inclined plane on its anterior edge used alone as in conjunction with the alignment wires and intermaxillary force is a well-known method of development of the regions of deficient

growth in the vertical plane. In Fig. 880 B is illustrated an improvement of the roofplate for this purpose in the addition of crib attachments for deciduous molars or premolars. The triangular arrangement of the



A B

FIG. 880.—(A) Labial alignment arches with triangular use of intermaxillary elastics used with rubber roofplate (B) with inclined plane and crib attachments.

intermaxillary elastics for assisting in vertical development in the molar and premolar region is shown at A in Fig. 880. A combination of the roofplate with inclined plane with upper labial alignment arch, lower

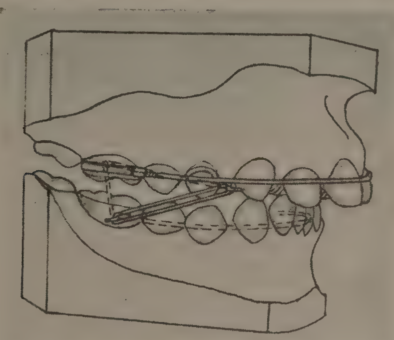


FIG. 881.—Upper labial alignment arch, lower lingual arch, intermaxillary force and inclined plane on roofplate in combination.

lingual arch and intermaxillary elastics is shown in Fig. 881, the lower incisors occluding with the inclined plane of the roofplate. If a labial

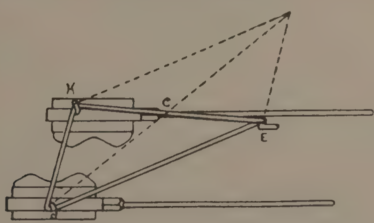


FIG. 882.—Dynamics of triangular use of intermaxillary elastics showing resultant force DC.

alignment arch is used for the development of the lower arch in the beginning, a removable lower lingual arch may later be substituted for this labial alignment arch and should be made as mobile as possible in its attachments in order that the lower molars may be free to move in the

direction of the forces exerted upon them mesially and vertically. The dynamics of this combination of the inclined plane and intermaxillary force exerted in the form of the triangle is shown in Fig. 882, the dotted line *DC* representing the resultant of the mesial and vertical forces of the intermaxillary elastics *KED*, this resultant force acting to develop the dental arches vertically and shift the occlusion from distal to normal at the same time.

As a delicate and efficient substitute for the roofplate the inclined plane has been constructed upon a removable lingual arch wire as in Fig. 883,

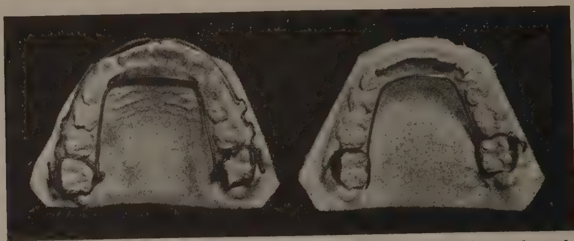


FIG. 883.—Metal inclined plane soldered to upper lingual arch.

a new layer of metal being added occasionally as the necessity indicates. Inclined planes of metal upon individual incisor bands have been used to give greater freedom and mobility of tooth movement in cases of deep overbite.

A modification of the bite-plate principle has been embodied in an inclined plane of 26 gauge clasp metal, Fig. 884, soldered to the lingual

FIG. 884.—Inclined plane of clasp metal soldered to upper incisor bands. (*After Reoch.*)

surfaces of gold bands, cemented upon the upper central incisors. This suggestion of Dr. Reoch in various forms is adaptable in many of the fixed inclined planes in use at the present writing for changing the deep overbite, and it is useful as well in the retention of these cases.

Another form of the bite plane suggested by Dr. J. Lowe Young is seen in the looped wire plane, Fig. 885, soldered to a removable lingual arch attached with the latch lock to the molar bands, and supported anteriorly by a spring lock on incisor bands. In order to establish the bite plane so that the upper incisors are not bound together, and so that each incisor may have freedom to exercise its function in

occlusion, Dr. Chas. Hawley has suggested the use of the individual loop or staple planes as in Fig. 886.

These inclined planes upon rubber roofplates, lingual arch wires or individual teeth are more adaptable for the treatment of "mixed

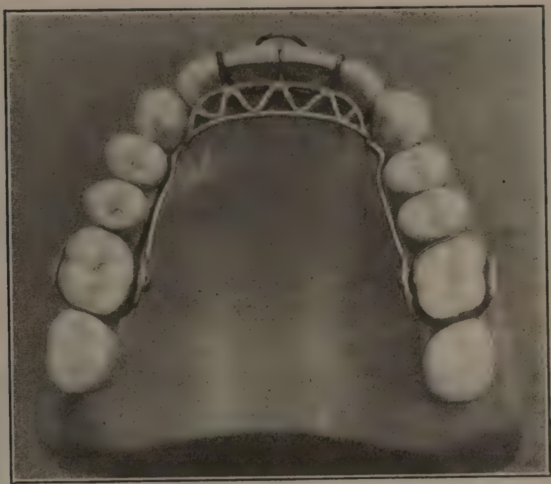


FIG. 885.—Looped wire inclined plane attached to lingual arch supported anteriorly by spring lock on incisor bands. (*After J. Lowe Young.*)

dentures," by extruding the first molars to a new level, and thus providing the proper plane of occlusion to which the premolars will later erupt, while in the more mature cases with canines and premolars erupted, the occlusal plane is already formed upon the abnormal curve, necessitating a correction of this curve before the distoclusion can be corrected. The inclined plane is not, therefore, directly adaptable for the correction of the abnormal curve of the occlusal plane, although it has been used to correct the abnormal overbite even in some of the most extreme cases.

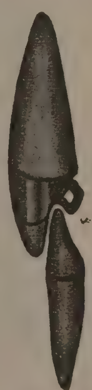


FIG. 886.—Individual inclined planes on incisor bands. (*After Hawley.*)

Treatment of the Permanent Denture in Distoclusion, (Class II Div. 1. Abnormally Deep Overbite).—The treatment of the permanent dental arches in this division of Class II, on account of the abnormal relations of the occlusal plane and the deep overbite, which is already firmly established, may be conducted along somewhat similar lines to those suggested for the treatment of the "mixed dentures" except in those cases exhibiting a marked deviation of the occlusal plane from the normal in either dental arch.

The abnormal curve of the occlusal plane, strange as it may seem, does not usually occur in both dental arches to the same extent, and may be more abnormal in the lower arch in one

case, and in the upper arch in another. Fig. 887 illustrates the abnormal curve greater in the upper arch than in the lower and Fig. 888 exhibits the abnormal curve greater in the lower than in the upper dental arch.

The correction of the abnormal curve is produced in the same manner in either the upper or lower arch by means of a small gauge alignment

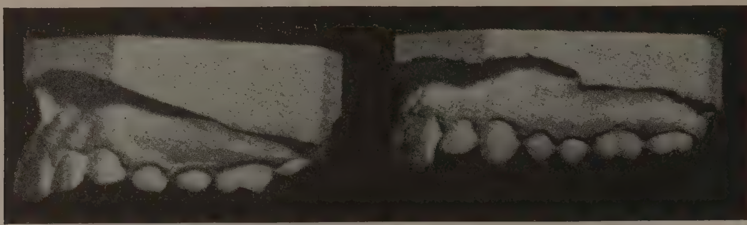


Fig. 887.—Upper casts of complex distoclusion case showing greater abnormal curve of occlusal plane than in lower.

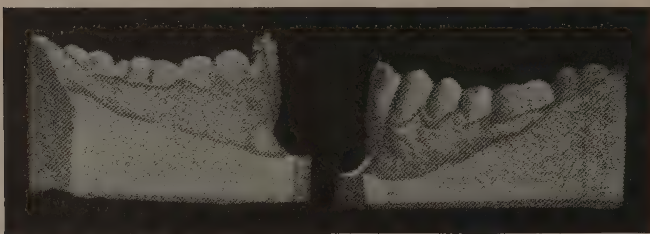


Fig. 888.—Lower casts of complex cases of distoclusion showing greater abnormal curve of occlusal plane than in upper.

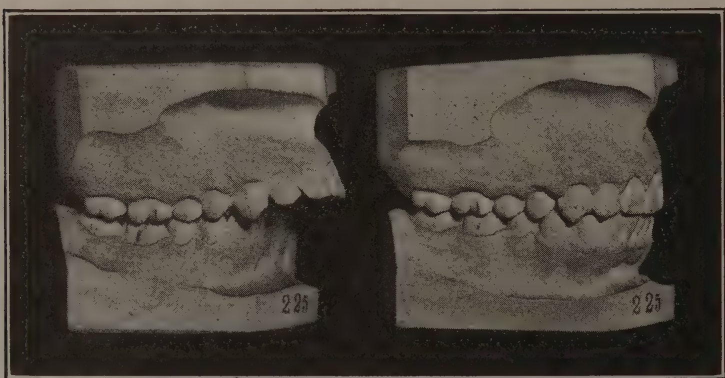


Fig. 889.—Case VI. Complex case of distoclusion before and after treatment. Age 17.

arch wire used as a double elastic lever. The dental arches should first be developed to their proper size and shape and a delicate .030 inch alignment arch wire then arranged as a double elastic lever upon the dental arch which exhibits the shorter and more abnormal curve.

Case VI.—An adult complex case of Class II, Div. 1, exhibiting the abnormally deep overbite, and with the abnormal curve in the occlusal plane of the lower arch is shown in Figs. 889 and 890 in the before and after-treatment casts.

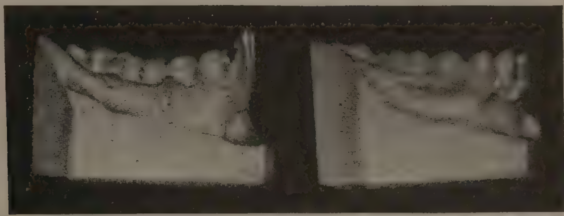


FIG. 890.—Case VI. Change in the occlusal plane of lower arch through treatment of infra-version of bicuspids and molars.

In Fig. 891 is illustrated the alignment arch wire used as a double elastic lever upon the lower arch of the case shown in Fig. 890 to extrude the bicuspids, intrude the incisors, and correct the abnormal curve of the occlusal plane. Fig. 890 shows the change in the occlusal plane of the lower arch after treatment. Fig. 892 exhibits the combination of appliances used in the case to correct the distal occlusion, after the force of the double elastic lever was well under way in its work upon the lower dental arch.

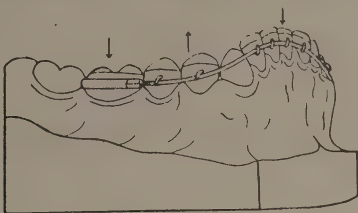


FIG. 891.—Case VI. Extruding bicuspids and intruding incisors in lower arch of distoclusion case, using labial alignment arch.

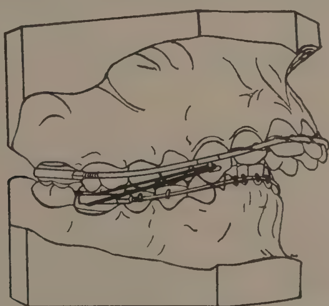


FIG. 892.—Case VI. Labial arch on upper combined with intermaxillary force to shift the occlusion mesio-distally.

Fig. 893 exhibits the change in the profile of the case shown in Fig. 890, after-treatment. The patient was 17 years old, and for this reason

Fig. 893.—Case VI. Profiles before and after-treatment.

the pleasing result obtained was all the more gratifying in view of the overcoming of the unusually difficult obstacles in the case.

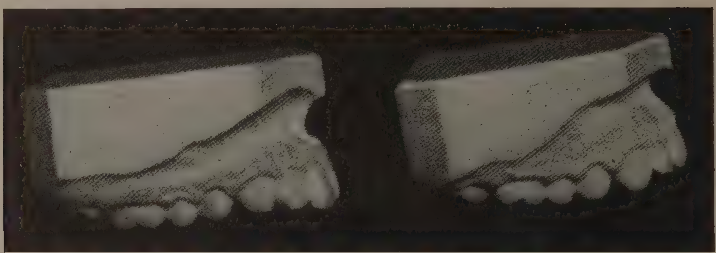


Fig. 894.—Upper casts of case of distoclusion in which the occlusal plane is changed by correcting the infraversion in bicuspid region.

The writer has modified the double elastic lever to a considerable extent, changing it from the heavier threaded wire to the threadless align-

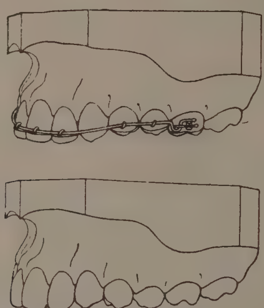


Fig. 895.—Correcting occlusal plane of upper arch with .030 inch labial alignment arch removable in the vertical plane.

ment wire of .025 inches to .030 inches in diameter, making the appliance much more delicate, yet with greater usable elasticity.

As the bicuspids are extruded and the incisors intruded, the arch wire will need to be bent to continue the exertion of the reciprocating force until the proper plane of occlusion has been obtained, which will be indicated by

the normal overbite of the incisors, when the completion of the case will require the shifting of the occlusion from distal to normal, although in some cases this will occur without resorting to intermaxillary force.

In distoclusion cases in which the abnormal occlusal plane is found in the upper arch as in Fig. 894, exhibiting the before and after-treatment casts, with the deep overbite in evidence, the change must be made in the curve of the upper occlusal plane in a manner similar to that of changing the lower occlusal plane.

The appliances used in the upper arch in this case consisted of a .030 inch labial arch, Fig. 895, attached by vertical half round tubes to molar bands, extending above spurs on bicuspid bands and under spurs on incisor bands. The drawing in the lower half of Fig. 895 shows the change in the occlusal plane after-treatment.

In some compound and complex cases of distoclusion of Class II, Div. 1, especially of adults, it will be found impossible to obtain normal relations of occlusion for some reason or another. In one case the patient will not follow instructions and faithfully wear intermaxillary elastics, in another, the patient will not keep regular appointments, while in cases of mature age, nature will not respond to a growth stimulation when the proper period for that growth has passed.

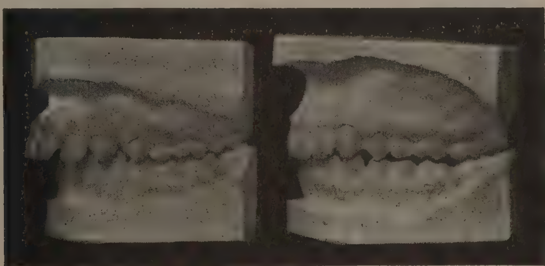


FIG. 896.—Case VII. Partial shifting of occlusion in complex case of distoclusion.

In these cases the orthodontist must either be satisfied with the improved result in occlusion and facial lines, or resort to the extraction of one or both upper first bicuspids and retract the upper anterior teeth to obtain the most esthetic facial effect.

Case VII.—Fig. 896 illustrates a complex distoclusion case in which the author could only obtain a partial shifting of the occlusion during the time the case was under his care, the patient going away to school and discontinuing active treatment. The effect of the treatment on the facial lines, however, as shown in Fig. 897 is much more pleasing than if extraction of two of the upper bicuspids had been resorted to as has been recommended by some authors.

There are other cases of Class II, Div. 1 which are unresponsive to the treatment of attempted restoration of normal mesio-distal relations, and in these cases, it is advisable to extract two upper bicuspids, usually the first, and retract the remaining anterior teeth with the use of intermaxillary force in order to obtain proper esthetic relations of the facial contour.

Treatment of Class II, Div. 1, Infraversion.—One of the most difficult complications occurring in any class of malocclusion is that of the "open bite," the infraversion, or lack of occlusion extending from the central incisors distally sometimes as far as the first and second molars, the arches being separated anteriorly from one-sixteenth to one-half an inch, according to the degree of malformation present.

Fig. 897.—Case VII. Profiles before and after partial restoration of mesio-distal relations of occlusion.

The inability to close the teeth anteriorly renders mouth-breathing more or less of a necessity, since lip function is almost entirely lacking in these cases, and the distortion of the features is much more displeasing than if only the distal occlusion were present.

The combination of "open bite" malocclusion and distoclusion is such as to increase the difficulties of treatment, and sometimes to baffle the efforts of the most expert operator.

In the treatment of an "open bite" distoclusion of the first division of Class II, the advisability of applying force for the restoration of the normal mesio-distal relationship simultaneously with, or previous to, the application of force for the closing of the bite, will depend largely upon the age of the patient and the extent of the infraversion of the anterior teeth.

In a child under twelve years of age, the greater possibilities of development and growth of the alveolar process and underlying bony tissues of maxilla and mandible, might call for much more ideal treatment than in a more mature case.

For example, the distoclusion and "open bite" malocclusion would respond readily to treatment, and if normal breathing and lip function

were restored and an effectual retention of the restored occlusion secured in the child under twelve years of age, success in the attainment of ideal results may be somewhat assured.

In the adult the conditions for ideal treatment are very unfavorable, since, although it might be possible to restore the normal relations of occlusion and close the bite by the efficient use of intermaxillary force, the indefinitely continued use of the same force, with a multiplicity of bands

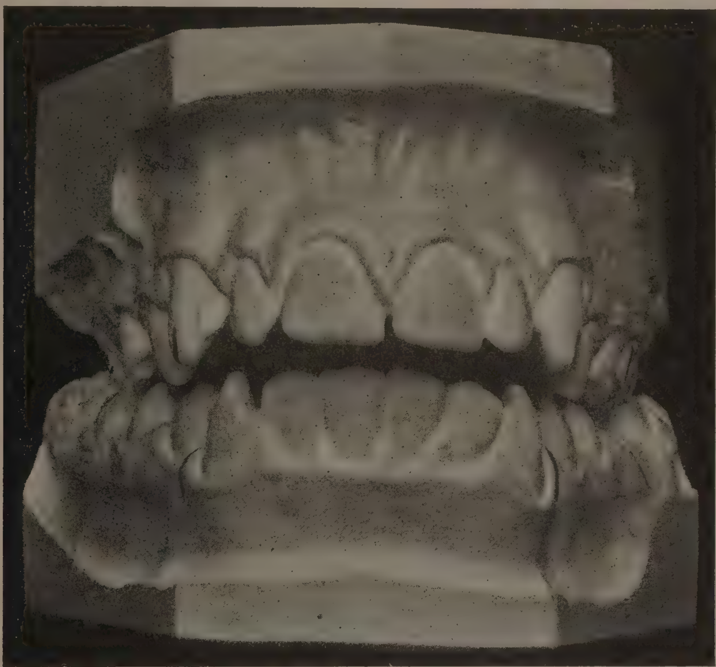


FIG. 898.—Case I. Infraversion of anterior teeth in case of bilateral distoclusion (front view).

and wires for the retention of the normal relationship, would render it somewhat inadvisable in the majority of cases.

However, there is a method of treating such a case which appeals to the author as reasonable and practicable, both from his own experience and from that of others, viz., to close the bite by grinding down the cusps of molars and bicuspids, allowing the front teeth to occlude.

Case I.—To illustrate, in Figs. 898 and 900, is exhibited an "open bite" bilateral distoclusion of a fifteen year old boy, an habitual mouth-breather, anemic in temperament, and with so few of the teeth in contact that mastication of his food was an impossibility. To add to the difficulties of treatment, the upper right first and second molars were in linguoversion, and the crown of the lower left first molar was destroyed by caries.

In order to be conservative of anchorage, the first step in the treatment was to bring the upper molars into buccal positions, and allow them to settle into occlusal relations with the lower molars before proceeding with the further treatment of the case.

The alignment arches and rubber elastics were then adjusted as in Fig. 865, for shifting the occlusion, which was successfully accomplished after a few months' treatment, but with the result that the anterior open bite was somewhat increased, as is usual in these cases.

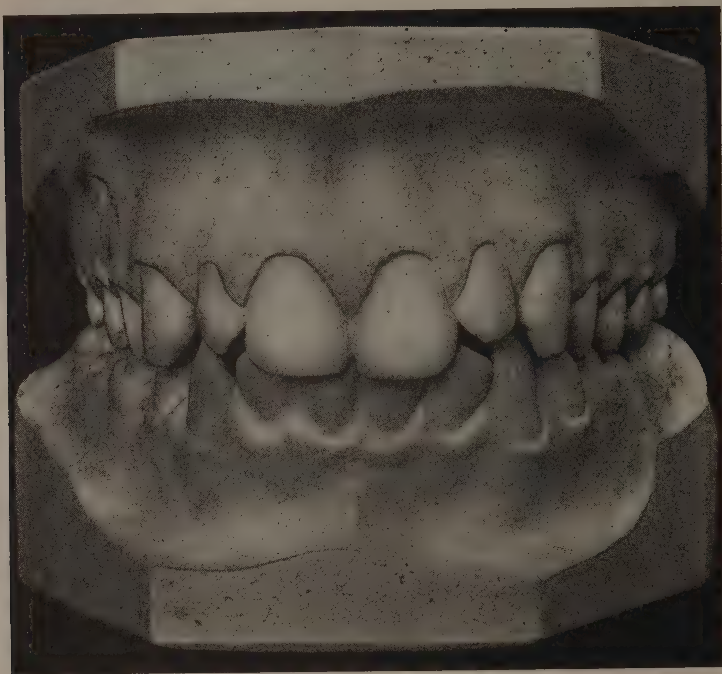


FIG. 899.—Case I. After treatment with appliances and grinding molars and bicuspids (front view).

Although not assured of successful retention of the mesio-distal relationship of the arches and the occlusion of the anterior teeth, intermaxillary force was applied between the upper and lower incisors, cuspids, and bicuspids, as in Fig. 827, with the result that although these teeth moved more or less readily into occlusion, the appearance was not as much improved as might be expected, the incisors elongating to an abnormal extent, and not carrying the process with them.

The intermaxillary force was withdrawn, and the anterior teeth allowed to settle back into their former positions, and the method of treatment changed in a manner that has proved of more permanent value. The

plan was adopted of so grinding the molar cusps of both upper and lower molars to close the bite that the inclined planes could be made to act as a permanent retention for the restored mesio-distal relationship of the arches, and by very carefully grinding one cusp at a time, and exaggerating the distal inclines of the lower and the mesial inclines of the upper molar cusps, this desirable result was effected, retaining the normal mesio-distal relationship without the aid of any appliance such as the interlocking planes usually used for the purpose.

The front view of the restored occlusion may be seen in Fig. 899, and the effectual interlocking of inclined planes of the cusps of the molars

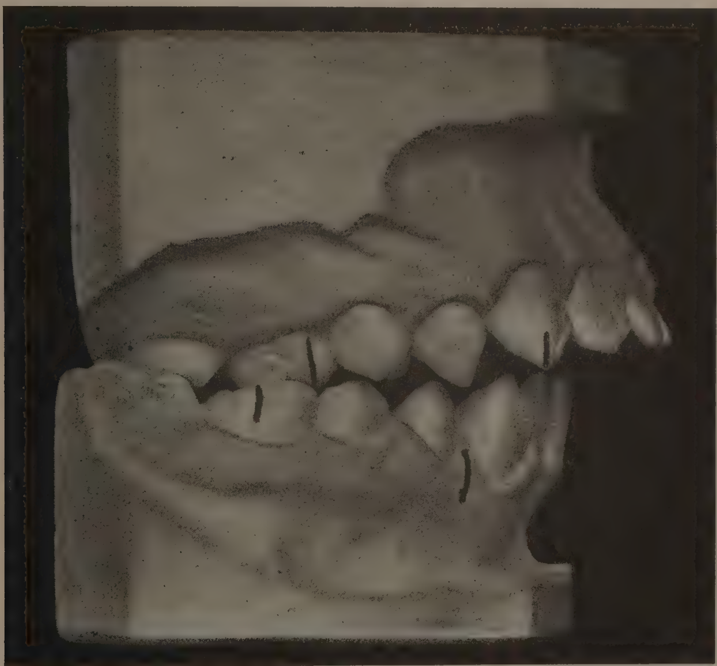


FIG. 900.—Case I. Infraversion of anterior teeth in a case of bilateral distoclusion (side view).

and bicuspids in Fig. 901 is of more than passing interest in view of the difficulties surrounding this class of cases in which distoclusion, "open bite" malocclusion, or infra-version, and the confirmed habit of mouth-breathing were such insurmountable obstacles to any other method of treatment.

One very gratifying feature of the treatment was that the boy had been examined by a rhinologist previous to coming under the author's care, and, although adenoids had been found, it was considered best to await the

results of orthodontic treatment before they should be removed, and upon referring the case back to the nose and throat specialist, he was unable to find any adenoids, which was a surprise, as such an occurrence had not before been recorded.

The disappearance of these adenoids was no doubt due to the development of the upper arch, and restoration of normal occlusion, which gave better opportunities for normal breathing and better masticating function, so that the adenoid growths were reabsorbed through a restoration of functions which meant increased metabolism and consequent improved nutrition.

The author has also performed the operation of grinding the cusps of the molars and bicuspids in "open bite" malocclusions of the anterior teeth

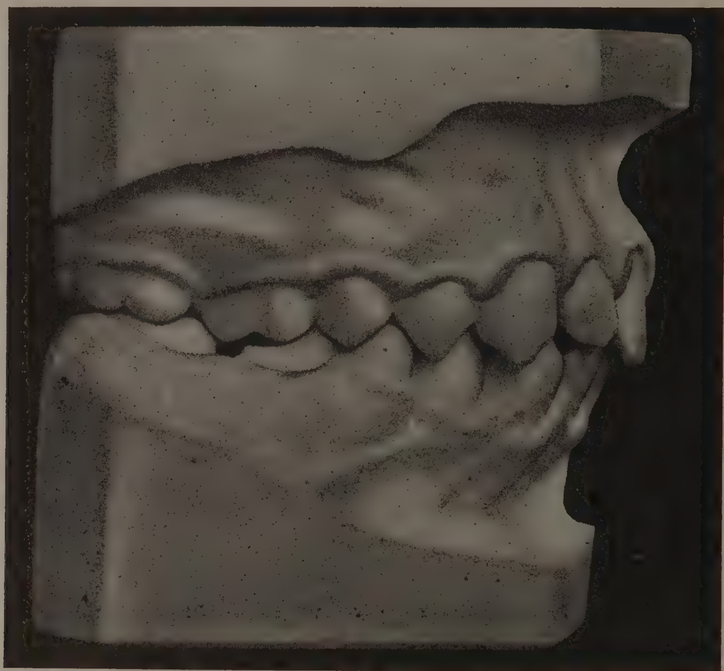


FIG. 901.—Case I. After treatment with appliances and grinding molars and bicuspids (side view).

of adult cases of Class I and Class III with very gratifying success. Care should be taken that the inclined planes be preserved in the grinding, and be made to serve the purpose of articulation as well as occlusion by trying the articular movements of the mandible during the process, and seeing that the stress of articular mastication is properly supported by both buccal and lingual cusps of molars and bicuspids, as is done in the grinding of artificial teeth upon an anatomical articulator.

In very severe cases of "open bite" malocclusion, it may be found necessary to devitalize the pulp of one or more of the molar teeth, since the pulp cavity will have to be partially encroached upon in order to do sufficient grinding to secure occlusion of the anterior teeth, and yet this need not be considered an objection in view of the benefits obtained through the proper performance of masticatory function, and the alleviation of the mouth-breathing habit.

CHAPTER LV

TREATMENT OF CLASS II, DIV. 1, SUBDIVISION

Treatment of Class II, Div. 1, Subdivision.—The characteristics of the subdivision of Div. 1, Class II are very similar in the general appearance of the dental arches to those of the full first division, the upper incisors being protruded, the upper arch narrow, and the facial disfigurement almost identical, the distinguishing feature of the subdivision being the unilateral distoclusion, one lateral half exhibiting normal mesio-distal relations.

The treatment, therefore, follows along the same lines as if the occlusion was bilaterally distal, except that it is obviously unnecessary to shift the occlusion on the normal side, although intermaxillary elastics of less strength may be applied on that side to assist in balancing the forces on each side of the mouth.

Case I.—Figs. 902 and 904 exhibit a case of Class II, Div. 1, subdivision, in which the right lateral half is in distoclusion, the left being in normal mesio-distal relations in the region of the first permanent molars. The space for the eruption of the lower left second bicuspid being partially lost through premature loss of the deciduous second molar, the lower left first bicuspid and cuspid drifted into this space until they occupied distal positions.

The alignment arches were applied in the same manner as described for the treatment of the full bilateral distoclusion, the mesial force upon the lower left first molar being compensated by the distal force exerted by the alignment arch in forcing the lower left cuspid and first bicuspid mesially into their normal positions. This latter movement was expedited by ligating from a lingual spur upon a band on the first bicuspid to a spur on the alignment arch slightly forward of the first bicupid.

After restoring the size and shape of the individual arches, and shifting the occlusion to normal relations, the result shown in Figs. 903 and 905, in right and left occlusion, was obtained.

Intermaxillary retention was used in this case for a few months only, as the tendency of the dental arches was to remain in normal relations after normal occlusion and function of the occlusal planes had been restored.

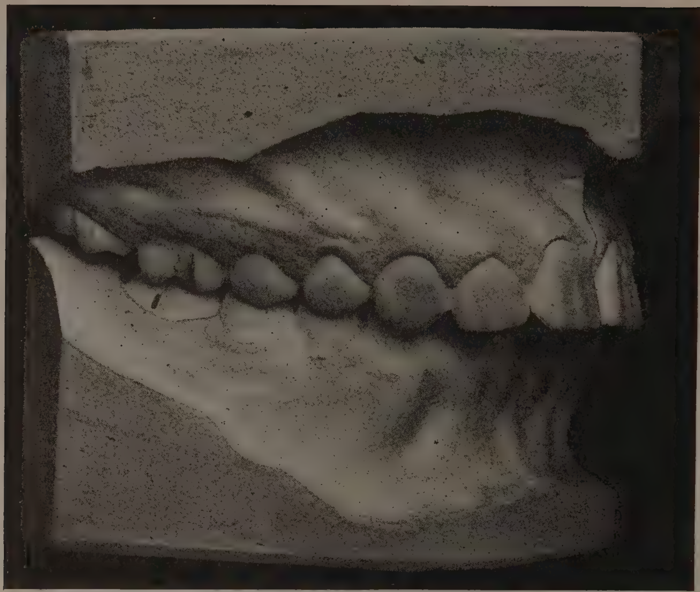


FIG. 902.—Case I. A unilateral distoclusion case before treatment (Class II, Div. 1, Sub.) (right side).

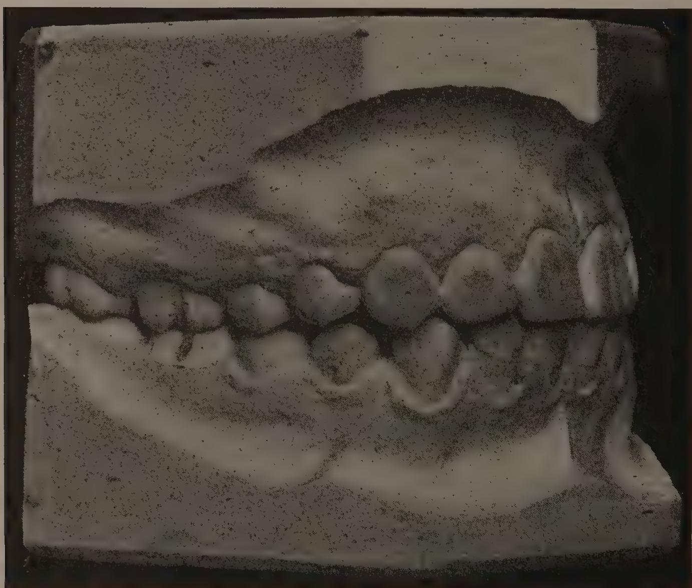


FIG. 903.—Case I. After treatment of case shown in Fig. 902 (right side).

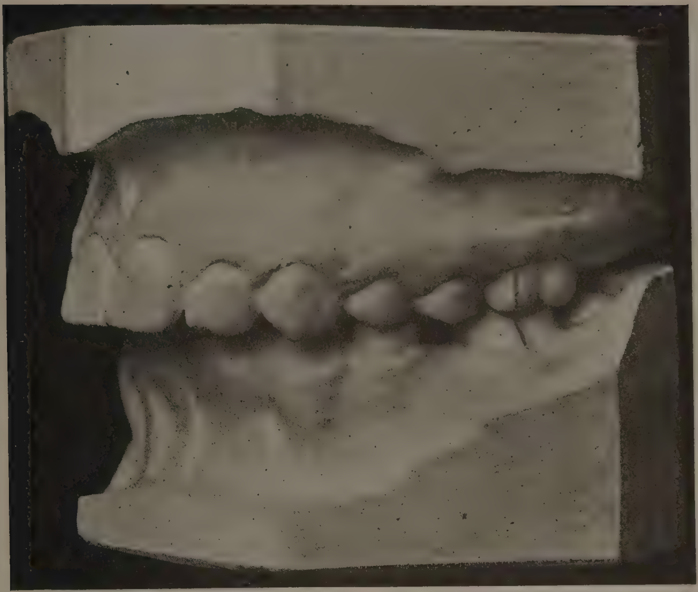


FIG. 904.—Case I. A unilateral distoclusion case (Class II, Div. 1, Subd.) before treatment (left side).

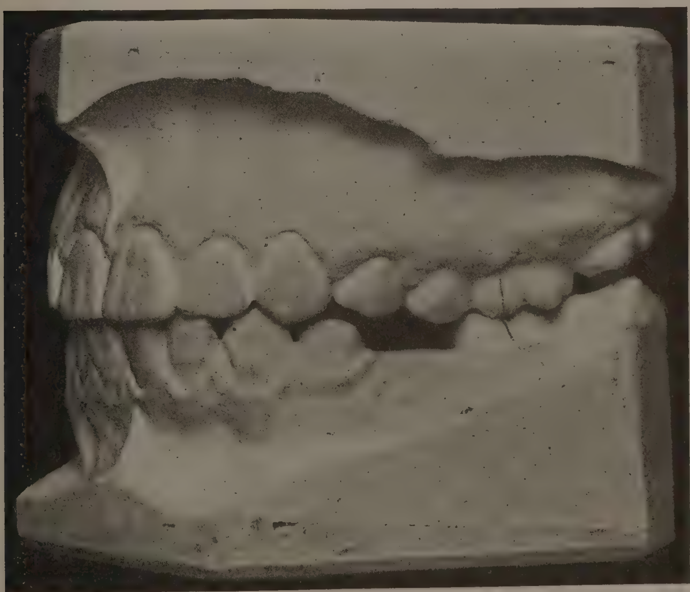


FIG. 905.—Case I. After treatment of case shown in Fig. 904 (left side).

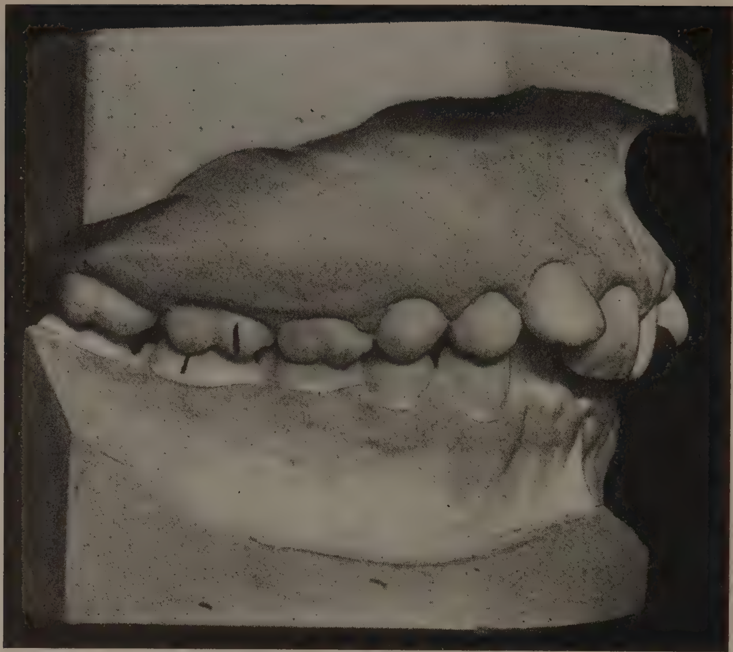


FIG. 906.—Case I. Bilateral distoclusion with retruded upper incisors (Class II, Div. 2) before treatment.

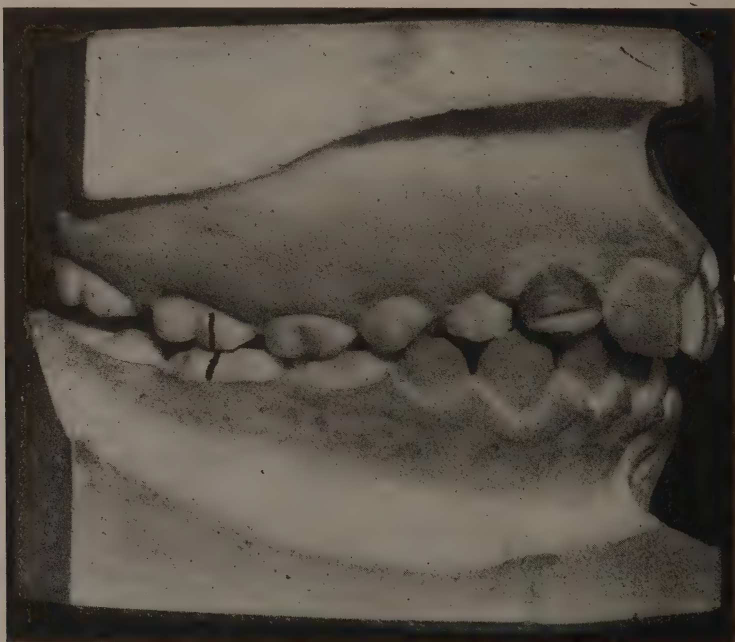


FIG. 907.—Case I. After treatment of case shown in Fig. 906.

CHAPTER LVI

TREATMENT OF CLASS II, DIV. 2

Treatment of Class II, Div. 2.—The occlusal characteristics of the second division of Class II include a distoclusion of both lateral halves of the dental arches, with contraction of the anterior portion of the upper arch, usually presenting with some of the upper incisors inclining lingually, or overlapping, as illustrated in the classification chart.

As with the first division of this class, the profile shows the effect of the distal occlusion, though not to such a marked degree, the lower third of the face being more uniformly receded from the normal pose.

Although cases of this division are usually normal breathers, it is not unusual to find mouth-breathers among them.

The distoclusion in this division is probably in existence in the deciduous arches before the eruption of the first permanent molars, and the upper incisors are forced into lingual and overlapping positions through nature's effort to conform the arches to some uniformity in size for better occlusion, the pressure of the lips being powerful factors in such arch conformation.

Case I.—Fig. 906 illustrates the right occlusion of a case of bilateral distoclusion in an eleven year old child, the upper central incisors inclining lingually and overlapped by the lateral incisors. In the treatment of this case, the intermaxillary elastics were applied for shifting the occlusion to normal mesio-distal relations, keeping the upper central incisors clear of the lower incisors by developing the upper arch and moving the deflected central incisors towards their normal positions a little in advance of the mesial movement of the lower dental arch.

The restoration of normal relations of occlusion in Fig. 907 is of exceptional interest in that the mesio-distal relations of the arches were not artificially retained, the normal function of occlusal planes of the teeth being sufficient to hold the dental arches in their normal pose. The only retaining appliance worn consisted of a lingual retainer for the upper central incisors, being attached to bands upon the lateral incisors.

Case II.—A case of the second division of Class II in which the infraversion in the molar region is very marked, Fig. 908, was treated by open-

ing the bite through placing crowns on the deciduous molars, elevating their occlusal surfaces to a new occlusal plane and developing the first permanent molars to the new occlusal plane by intermaxillary force.

This method of correcting the deep overbite and abnormal plane of

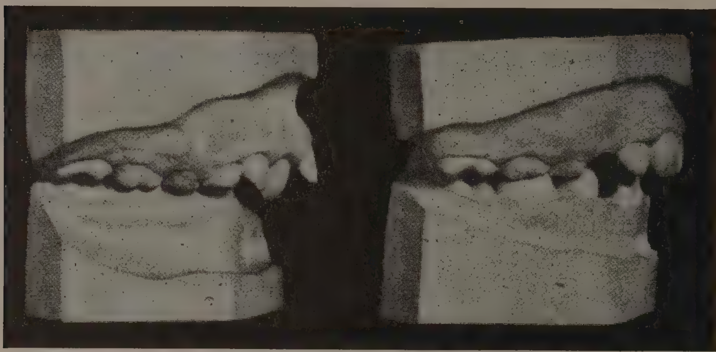


FIG. 908.—Case II. Opening the bite in a distoclusion case (model on right) by means of crowns upon deciduous molars. Model on left before treatment.

occlusion by vertical development in the molar region depends for its applicability upon the stability of the deciduous molars, and can only be accomplished by initiating treatment some little time previous to the absorption of the roots of these teeth. A radiograph will determine

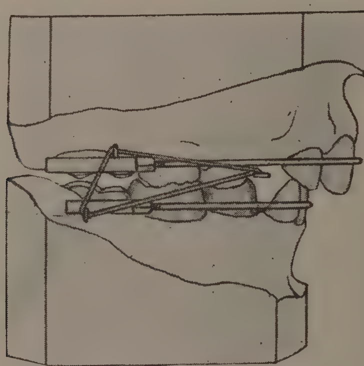


FIG. 909.—Case I. Labial alignment arches, crowns on lower deciduous molars, and intermaxillary elastics arranged to correct infraversion and distoclusion.

whether absorption of the roots of the deciduous molars has begun, and if it has progressed to any extent, the method should not be attempted.

In brief the method consists of crowning the lower deciduous molars and thus opening the bite until the first permanent molars can be erupted

to the proper occlusal plane. Fig. 909 illustrates the combination of crowns on lower deciduous molars, alignment arch on the upper arch, labial or lingual arch wires on the lower arch, and intermaxillary face applied

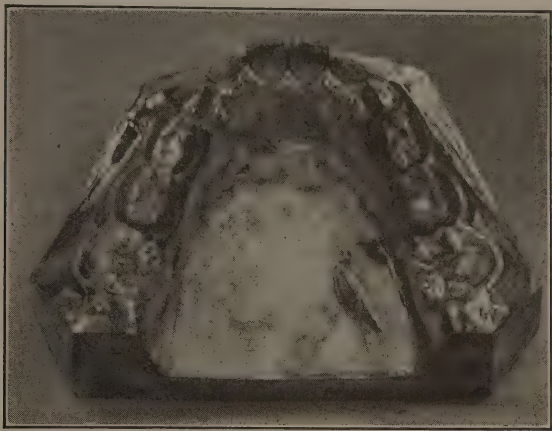


FIG. 910.—Artificial stone cast exhibiting ground surfaces of deciduous molars over which are made the carved wax pattern for the gold "overlays." (*After J. Lowe Young.*)

triangularly to get vertical development as well as a mesial shifting of the occlusion of the lower teeth. Fig. 908 exhibits two stages only of the treatment of a second division case of distoclusion by this method.

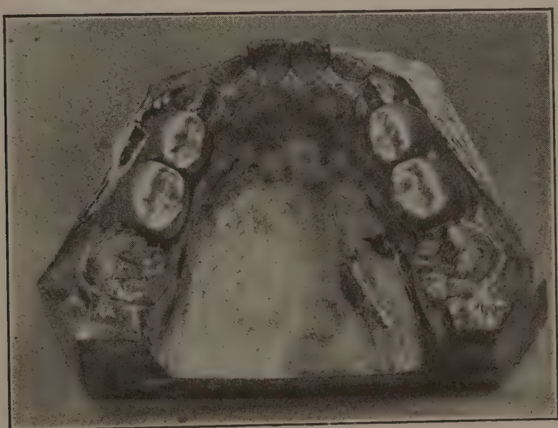


FIG. 911.—Gold overlays cast from the wax pattern in position on stone cast. (*After J. Lowe Young.*)

Dr. J. Lowe Young has devised an unique method in these cases of casting overlays for the first and second deciduous molars on each side in one piece and cementing these cast crowns into position.

The buccal and lingual surfaces of the lower first and second deciduous molars are ground off enough so that a wax "overlay" can be removed in the vertical plane without distortion, the mesial surfaces of the first deciduous molars and the distal surfaces of the second deciduous molars being similarly ground, as shown in Fig. 910. Wax patterns of the "overlays" are next made on this cast on a higher occlusal plane, cusps and sulci being carved to occlusion with the upper cast. The wax patterns of the "overlays" are next cast in gold alloy and cemented into position in the mouth, appearing as shown on the stone cast in Fig. 911.

CHAPTER LVII

TREATMENT OF CLASS II, DIV. 2, SUBDIVISION

Treatment of Class II, Div. 2, Subdivision.—The occlusal relations of one lateral half of the dental arches being normal in the subdivision of the second division of Class II, treatment for shifting the occlusion is necessary only upon the lateral half which exhibits distoclusion. Development of both arches, however, may be necessary, in order to secure normal size and shape of the dental arches.

Case I.—A characteristic case of this subdivision is illustrated, before and after treatment, in Figs. 913 and 914, right occlusion, and 915 and 916, left occlusion.

The distoclusion on the right lateral half is evident, and the apparent simulation of a distoclusion on the left side is due to the closing up of the

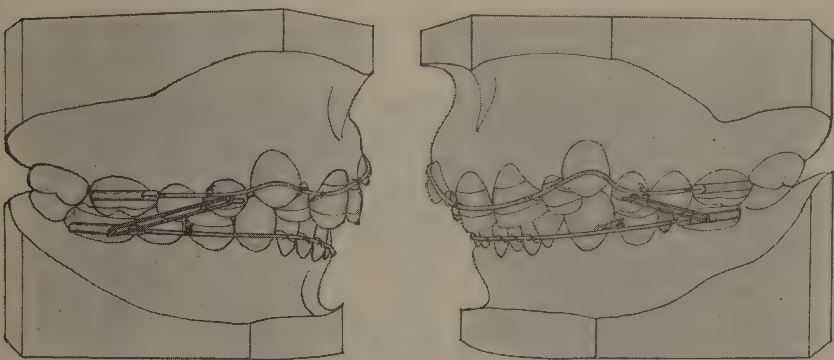


FIG. 912.—Case II. Upper and lower alignment arches in combination with intermaxillary force used in treatment of the case shown in Fig. 912.

space for the lower second bicuspid which is unerupted, allowing the first bicuspid to drift back until it is in contact with the first molar, carrying along with it by lack of anterior development, the cuspid and incisors on the left side.

An X-ray of the left side of the mandible revealed the presence of the second bicuspid, but, of course, unerupted.

Upon the adjustment of the alignment arches, Fig. 912, the upper with hooks for the intermaxillary elastics, and the lower with a spur opposite the lower first bicuspid which was banded and ligated to the spur, the inter-

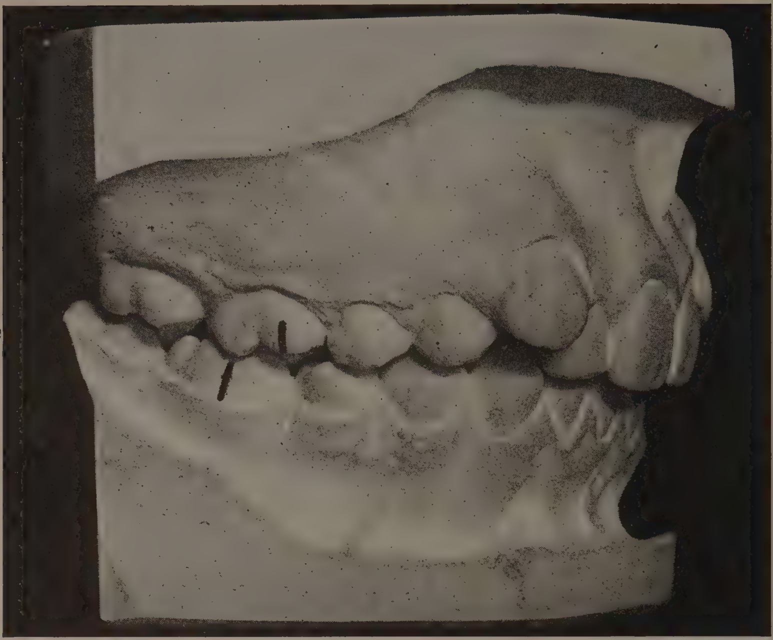


FIG. 913.—Case II. Malocclusion of Class II, Div. 2, Subdivision (right side).

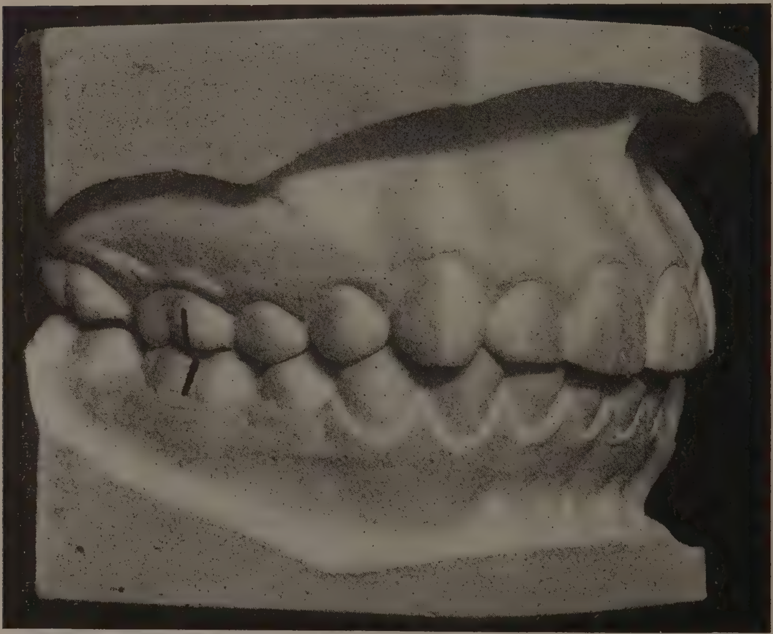


FIG. 914.—Case II. After treatment of case shown in Fig. 913 (right side).

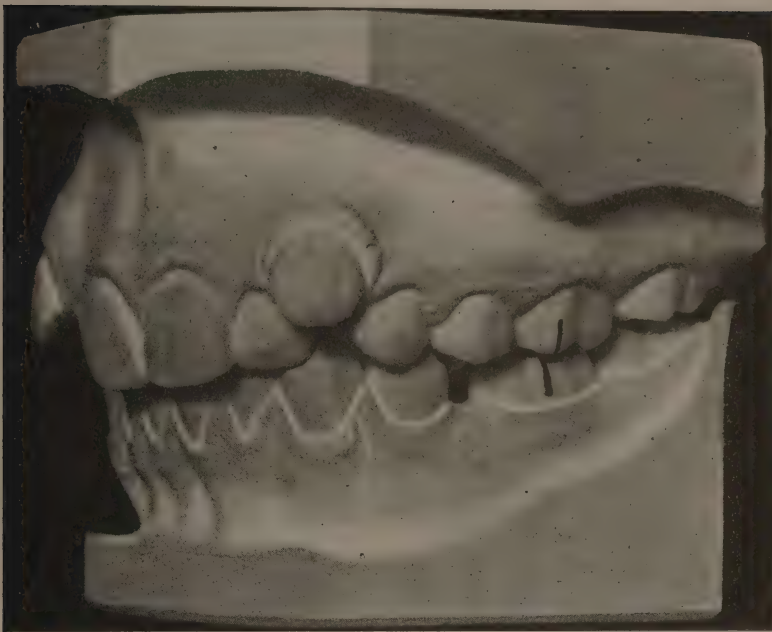


FIG. 915.—Case II. Left side of malocclusion shown in Fig. 913.

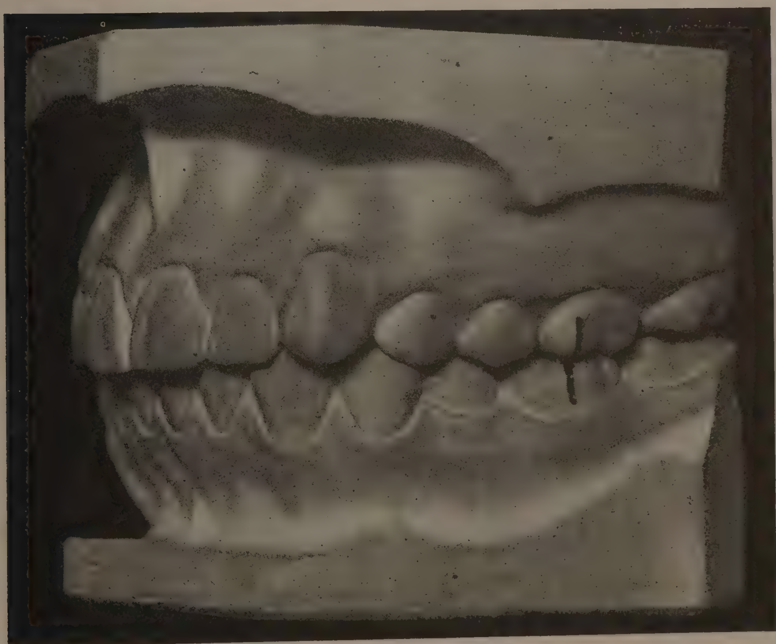


FIG. 916.—Case II. After treatment of malocclusion shown in Fig. 913 (left side).

maxillary elastics were applied to both sides of the arches, that on the right being adjusted to shift the distal occlusion to normal, and the one on the left to re-enforce the lower molar anchorage which is to resist the force used to move the cuspid and bicuspid on that side forward in the line of the arch.

FIG. 917.—Case II. Profile before treatment. FIG. 918.—Case II. Profile after treatment.

The before and after-treatment profiles of this case, Figs. 917 and 918, show a decided improvement in the art relations of the face.

Treatment of Class II, Div. 2, by Extraction and Compensation of

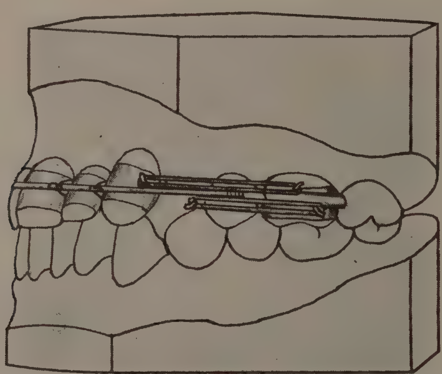


FIG. 919.—Combination of labial alignment arch and interdental facer of rubber bands for contracting arch and moving cuspid into place of extracted bicuspid.

Occlusion.—In some adult cases of Class II, Div. 2, in which it seems inadvisable to attempt to restore the normal relations of occlusion, the extraction of an upper first bicuspid on the side in distoclusion and the closing up of the

space by the distal movement of the adjacent cuspid and the alignment of the rest of the anterior teeth will provide for a compensation in the occlusion which will answer the purposes of esthetics.

The combination of the alignment arch with the anterior teeth ligated thereto, and interdental force, as in Fig. 919, illustrates a reciprocation of force which is conservative of the anchorage. The distally exerted force of the alignment arch through the ligation of the incisors is reciprocated in the mesially exerted force of the rubber elastic on the molar anchorage. As the cuspid is gradually moved distally, the nut on the alignment arch may be loosened and the alignment arch allowed to slide distally, aided by another elastic stretched from the hook on the alignment arch to the distal end of the tube on the anchor band.

CHAPTER LVIII

TREATMENT OF CLASS III (MESIOCLUSION)

Diagnosis of Class III.—This class usually presents with bilateral, and very rarely with unilateral, mesioclusion of the lower dental arch, and, in the extreme, is probably the most disfiguring of any class of malocclusion. In cases of this class the maxilla is usually considerably arrested in development, and the mandible protruded, with its incisors inclining lingually.

Most all of the cases of Class III are mouth-breathers, and naso-pharyngeal obstructions are unusually persistent. Accompanying many of these cases is the condition of "open bite" malocclusion, or infra-version of the anterior teeth, with its added difficulties of treatment.

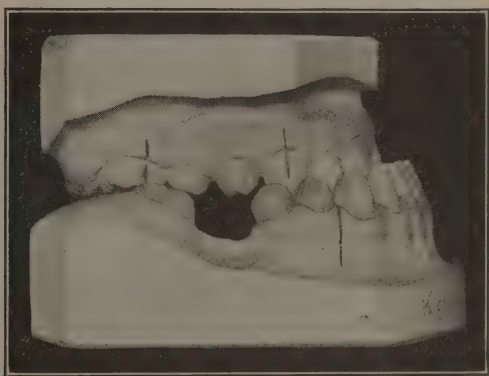


FIG. 920.—Adult case of mesiocclusion.

The inception of mesioclusion is during a very early period in child life, when it is least noticeable in the facial lines, and yet it is at this early period when the malocclusion should be diagnosed and the abnormal conditions overcome which are causative of it, if the most beneficial results are to be obtained. These cases may usually be diagnosed from the profile, the mandible being protruded, and the upper lip receding.

The etiological factors are somewhat obscure, although it is believed that the habit of holding the mandible forward to assist in breathing when the faucial tonsils are hypertrophied, has a strong tendency to cause the mesioclusion.

Hypertrophied or diseased tonsils should be removed as early as diagnosed, since if they are allowed to remain, it is impossible to overcome

the faulty breathing, and abnormal relations of muscles which persist in holding the mandible forward.

Fig. 920 illustrates the mesioclusion of a girl about eighteen years of age exhibiting the lingual locking of the upper anterior teeth and the confirmation of the malocclusion thereby through years of abnormal relationship of occlusion and facial muscles. The profile, Fig. 922 exhibits the effect

FIG. 921.—Case I. Profile of case shown in Fig. 922. Age 18.

of age which this malocclusion presents, the patient appearing many years older than her actual age.

The conditions of arrested development are usually persistent, the upper arch remaining small and undeveloped, and the lower arch changing in form according to the general direction of abnormal tension of muscles.

In severe cases of this class, the angles formed by the rami and body of the mandible disappear, leaving almost a straight line from the chin to the ear.

These extreme cases occasionally progress abnormally to such a degree that *malformation of the mandible* occurs, and, if they are within the possibilities of surgical treatment they should be treated along the lines of osseous deformities of the jaws.

Technique of Operative Treatment in Class III.—The operative treatment of the simpler cases Class III may be divided into two stages, the restoration of the normal size and shape of the dental arches, and the shifting of the occlusion from mesial to normal relations. The restoration of arch size and form, and the correction of malocclusion of individual teeth follows along the same methods for such tooth movements as in Class I.

There is seldom any need for a change in the occlusal plane, except in the complication of infraversion of the anterior teeth.

The use of the intermaxillary force for shifting the occlusion is necessary, as in Class II, although the direction of the force and the manipulation of the anchorage is exactly the reverse from that in the second class.

The direction and points of application of the intermaxillary force in treatment of Class III may be seen in Fig. 922, the elastics extending from the distal ends of the tubes on upper molar anchor bands, to the hooks on the lower alignment arch.

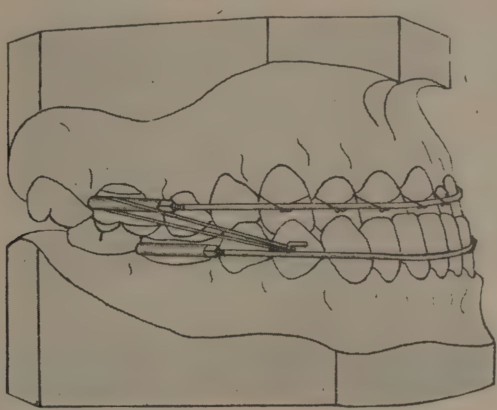


FIG. 922.—Treatment of mesioclusion by means of labial alignment arches and intermaxillary force.

In the treatment, proper ligation of the teeth in the upper arch to the alignment arch should be made according to the tooth movements desired, and in the lower arch according to the degree of re-enforced anchorage necessary to prevent the tipping distally of the lower molar anchor teeth, when the lower arch is used as a stationary anchorage to move the upper teeth mesially.

Owing to the fact that mesial movement of the teeth requires less force than distal movement, appliances almost always operate to move the teeth of the upper arch mesially more than to move the teeth of the lower arch distally in these cases.

It is considered especially advantageous in this class of cases to obtain, if possible, a deep overbite, or overlapping of the upper over the lower incisors after shifting of the occlusion, as the increased length of the inclined cusp planes serves to more effectually retain the restored relations of occlusion than where but a short overlapping is present.

It is advisable to begin the treatment of this class of malocclusion as early as it is possible to manage the child, for with added years comes an

exaggeration of the deformity, the mandible assuming a more forward pose, and the shape of the bone and the relations of the muscles becoming conformed to an abnormal condition which makes it much more difficult and sometimes impossible to completely overcome.

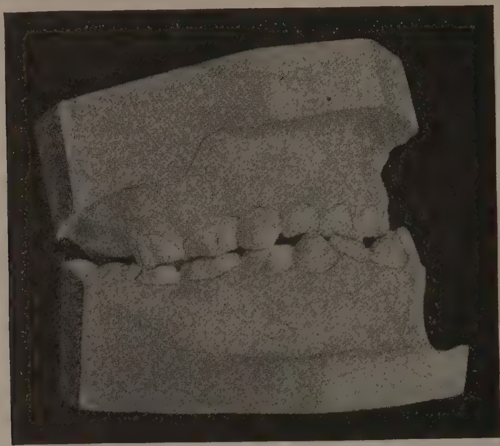


FIG. 923.—Case II. Mesioclusion at seven years.

Case II.—Fig. 923 exhibits the casts of the mesioclusion of a seven-year-old boy, from whose throat the adenoids and tonsils shown in Fig. 601 were removed at the beginning of treatment.

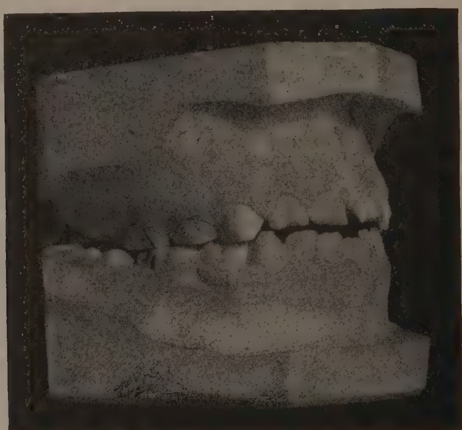


FIG. 924.—Case II. After treatment casts of mesioclusion shown in Fig. 923.

Anchor bands were fitted to the deciduous second molars and small gauge alignment arches adjusted as shown in Fig. 925, the intermaxillary elastics being attached in the same manner as in a dental arch of permanent teeth.

The occlusion was changed in a few weeks to that shown in Fig. 924 and a persistent retention by means of buccal spurs upon the molar anchor bands was established, and the case dismissed to be seen only at intervals of a couple of months, until the permanent teeth should erupt, in order that any untoward developments might receive immediate attention, should they arise.

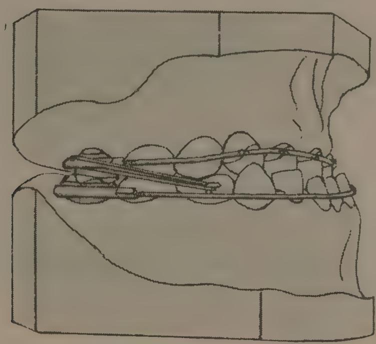


FIG. 925.—Case II. Treatment by means of labial alignment arches and intermaxillary force.

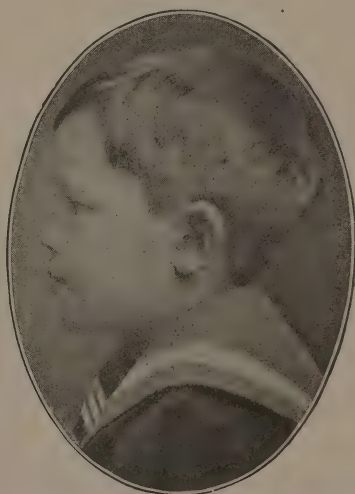


FIG. 926.—Case II. Profile before treatment. FIG. 927.—Case II. Profile after treatment.

The profile pictures of this case before and after treatment are exhibited in Figs. 926 and 927. After a year's retention, the development of the facial lines through the establishment of normal functions of occlusion and respiration was most gratifying. The treatment of this case was undertaken before the introduction of the lingual arch and the operative technique in the use of the labial alignment arches is given in order that the application of these appliances in the deciduous arches of a case of mesio-

clusion might be illustrated for the benefit of those who may not be familiar with other forms of appliances or combinations such as are shown in some of the succeeding cases.

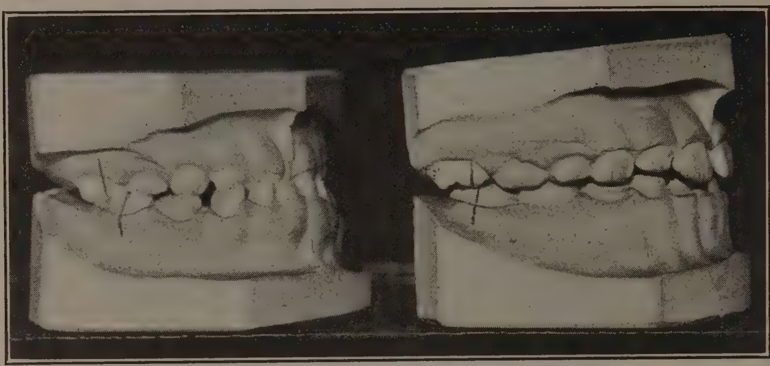


FIG. 928.—Case III. Bilateral mesioclusion of mixed denture before and after treatment.

Case III.—In the case of the mesioclusion shown in the before and after-treatment models in Fig. 928 the appliances used, Fig. 929 were a combination of a lingual arch with auxillary springs on the upper, and a

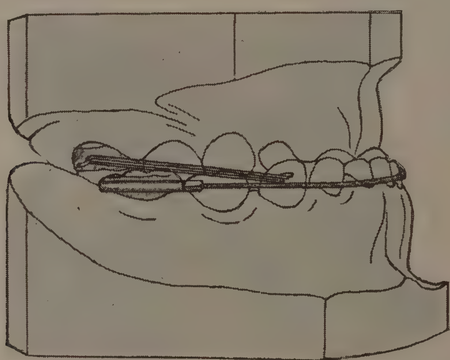


FIG. 929.—Case III. Treatment by means of upper lingual arch, lower labial arch and intermaxillary force.

labial alignment arch on the lower dental arch to which the lower anterior teeth were ligated. The intermaxillary elastics were then attached from hooks on the lower alignment arch to buccal hooks on the upper molar bands.

As the upper arch was developed and the mesio-distal relations changed to normal, the profile of the patient was also restored to its normal outline. Enlarged tonsils were removed at the beginning of treatment, and normal breathing conditions restored.

Case IV.—Another case of this class, the before treatment models of which are shown in Fig. 930, from the practice of Dr. M. T. Watson, is unusually interesting in view of the fact that the restoration of occlusion and facial lines was accomplished solely by means of the Angle chin cap and headgear, a combination which has fallen somewhat into disuse since

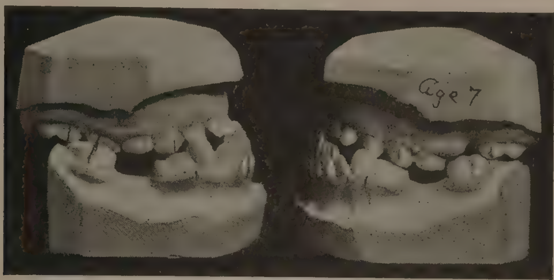


FIG. 930.—Case IV. Mesioclusion—age 7 years, before treatment.

the general adoption of intermaxillary force for the mesio-distal changes in occlusion.

Beginning with a very gentle elastic pressure for the first few days of treatment, two No. 33 Goodyear elastic bands were adjusted between headgear and chin cap on each side, followed in the course of a week by the substitution of a No. 000¼ for the lower of the two bands, which represented the maximum of force used in the treatment.

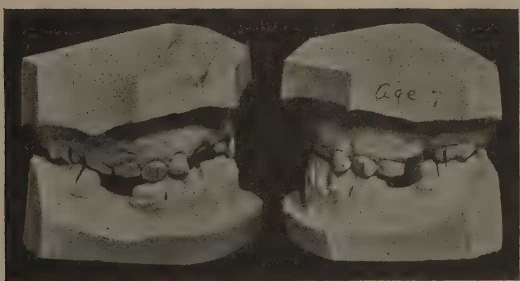


FIG. 931.—Case IV. Mesioclusion at 7 years treated by means of Angle headgear and traction bar.

Aside from a slight crowding of the lower incisors, the results of about six weeks' treatment produced almost normal mesio-distal relations of the dental arches, the final occlusal relations established being shown in Fig. 931. The necessity for the subsequent use of appliances inside of the mouth for perfecting the occlusal relations does not detract from the scientific value of the method just described for early treatment of this class of

cases, especially as it is the only recorded case in which the treatment was confined solely to the use of the chin retractor, and therefore exhibiting as Dr. Watson states, "a change which must necessarily be confined to the shape of the mandible itself, or to a change in the temporo-maxillary articulation, or both, the latter probably being the case."

Fig. 932 illustrates the before and after-treatment profiles of the case, the latter picture being taken about four months after the first one. The slight prominence of the lower lip in comparison with the upper may be accounted for by the loss of the upper deciduous central incisors during the treatment, and the lack of the permanent centrals being sufficiently erupted to lend any contour to the upper lip.

FIG. 932.—Case IV. Before and after treatment profiles.

Case V.—A comparatively simple case of this class, although a little older, is illustrated in Fig. 933 before and after treatment. This case was undertaken just as the bicuspids were erupting to occlusion, and the change from mesial to normal occlusion as a result of treatment gave the cuspids and bicuspids an opportunity to complete their eruption into normal locking with the inclined planes of their antagonists.

The alignment arches were placed upon both upper and lower arches and the intermaxillary elastics stretched from hooks soldered well forward upon the lower alignment arch to the distal end of the buccal tubes upon the upper molar anchor bands, as in Fig. 922. When the upper incisors are but slightly distal to the lower incisors as in this case, the first effort should be directed to moving the upper incisors into positions mesial to the lower incisors, so as to gain the advantage of the inclined planes of the lingual surfaces of the upper incisors acting upon the labial inclined planes of the lower incisors during the rest of the treatment, for until this change is made, the reverse action of the inclined planes of the incisors will tend to prevent a change in occlusion of the molars.

To accomplish this movement of the upper incisors, the lower alignment arch was securely ligatured to the lower incisors and bicuspids, and the lower arch used as a stationary anchorage, as it were. The upper

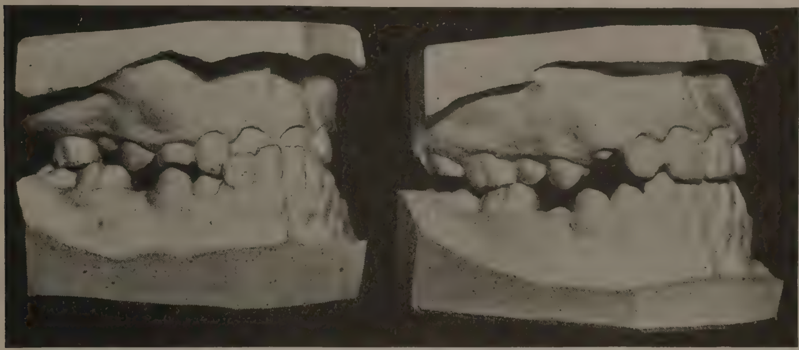


FIG. 933.—Case V. Mesioclusion of permanent denture before and after treatment.

incisors were then ligated to the upper alignment arch, the nuts in front of the anchor tubes turned up singly at each appointment and the intermaxillary force being constantly in action, not only prevented the upper

FIG. 934.—Case V. Profile before treatment.

FIG. 935.—Case V. Profile after treatment.

molars from distal movement, but hastened the mesial movement of the upper incisors.

After this change in the occlusion of the incisors was effected, the intermaxillary force, continuing in action, produced the change from mesial

to normal occlusion of the lower molars. It will be observed from the illustration, Fig. 933, that some development of both arches was accomplished at the same time.

Even with such a slight change in occlusion as is exhibited in this case, a very decided improvement in the facial lines is seen in the comparison of the before and after treatment profiles in Figs. 934 and 935.

Case VI.—A much more difficult case than the one just described on account of increased age and consequent greater density of alveolar tissues and conformation of occlusion and facial lines to abnormal conditions is illustrated in Fig. 936, the before and after-treatment models

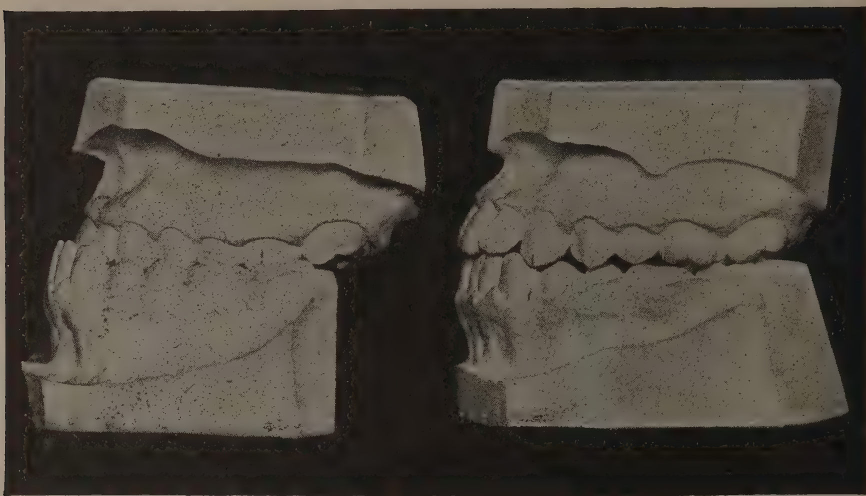


Fig. 936.—Case VI. Adult mesioclusion before and after treatment. Age 18.

being observed from the left side. This case was treated with *inclination movement* of the upper anterior teeth, and as would be expected in such an extreme case, there is some inclination of these teeth after treatment. The author treated this case before the appliances for bodily movement were introduced and while the after treatment model in Fig. 936 indicates the necessity for bodily movement, there is little indication of it in the comparison of the before and after-treatment profiles in Fig. 937.

Bodily Movements in Class III.—*Bodily movement* is indicated today in just such a case as illustrated in Fig. 936, and while it may be attained in the use of the plain labial alignment wire with vertical spring extensions occlusally from the alignment arch on the incisors and cuspids, or the pin and tube arch, the Angle ribbon arch with bracket bands as shown in Fig. 938, seems to offer one of the most ideal combinations for the purpose at the present time.

Case VII.—There are many cases occurring in practice which seem to be exceptionally difficult to diagnose and treat on account of the loss of many of the permanent teeth, and the consequent complications caused

FIG. 937.—Case VI. Profiles before and after treatment of case shown in Fig. 936.

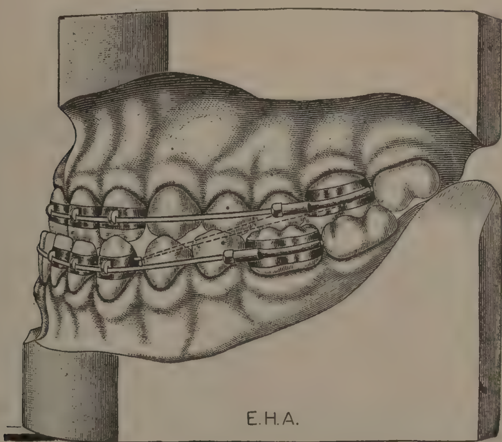


FIG. 938.—Bodily movement in Class III using the Angle ribbon arch and bracket bands.

by the migration and elongation of remaining teeth in already contracted arches.

A case of this character, age twenty years, belonging to Class III, is exhibited in Figs. 939 and 940, before and after treatment of both right

and left sides of the mouth. The loss of many of the teeth by caries and necessary extraction, and the elongation of teeth which had no antagonists, rendered it exceedingly difficult to treat, especially as the problems of anchorage for the use of intermaxillary force seemed rather uncertain.

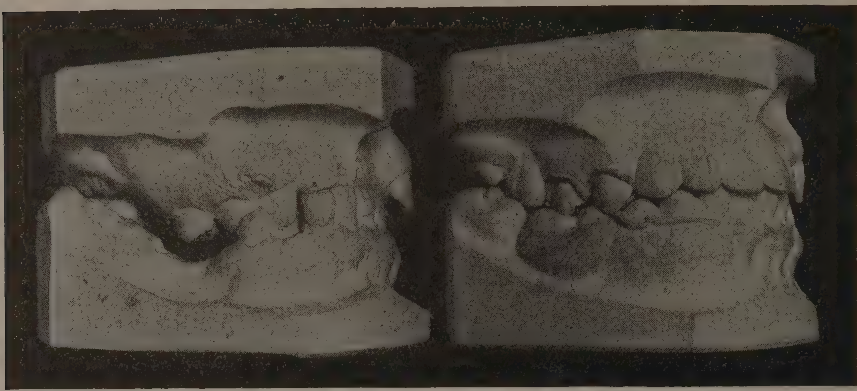


FIG. 939.—Case VII. Adult mesioclusion (complicated by extraction) before and after treatment. Right occlusion.

By a careful conservation of anchorage, however, the case was finally brought to a successful completion, the after treatment models being shown on the right of Figs. 939 and 940, with retaining appliances in position.

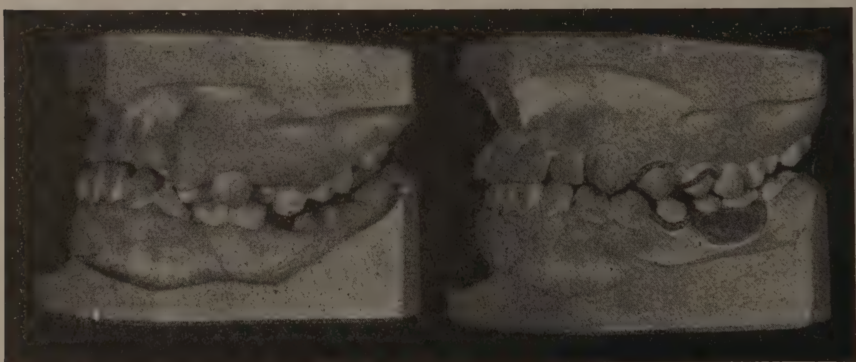


FIG. 940.—Case VII. Before and after treatment casts of case shown in Fig. 939. Left occlusion.

In this case the plate plays a very important part, not only in retaining temporarily the spaces regained for permanent teeth, but also supplying artificial substitutes for the missing natural teeth.

A view of the upper casts of this case in Fig. 941 shows the retention of five of the anterior teeth with a lingual wire soldered to the left cuspid and right lateral incisor band, and a roof plate, with spring clasp attachments and three artificial teeth, effecting the retention of the rest of the teeth in the upper arch.

Fig. 941.—Case VII. Upper casts before and after treatment showing retention.

Another plate with spring clasp attachments and artificial substitutes for natural teeth, accomplishes the greater part of the retention of the lower arch as illustrated in Fig. 942. The profile of this case, before and after treatment, is exhibited in Fig. 943, the improvement in facial contour being very pleasing.

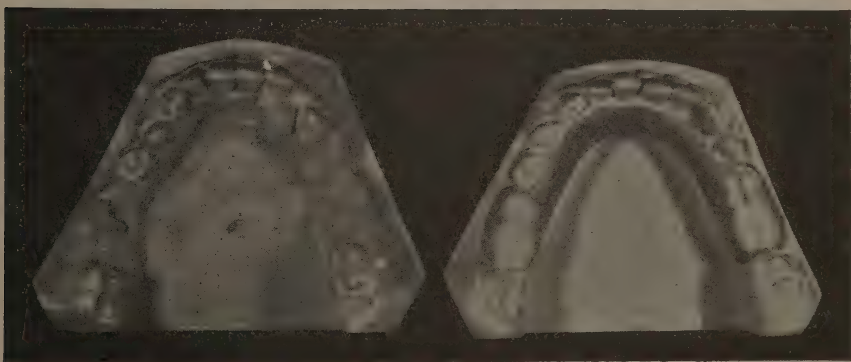


Fig. 942.—Case VII. Lower casts before and after treatment showing retention.

At a later period, the plates were removed and bridge-work inserted for permanent retention and increased function of mastication which was attained.

FIG. 943.—Case VII. Profiles before and after treatment.

Treatment of Class III, Division.—The treatment of the one division of mesioclusion in which one lateral half is in neutroclusion, or normal mesio-distal relations, varies but little from the treatment of full bilateral mesioclusion other than that the teeth in normal mesio-distal relations are not moved except as they may be buccally or lingually moved in the restoration of arch form.

Unilateral mesioclusion is very rare, although it is recognized as a division of Class III, and its treatment indicated accordingly.

CHAPTER LIX

MALFORMATIONS OF THE MANDIBLE AND THEIR TREATMENT

Diagnosis.—Malformations of the mandible, uncomplicated by previous surgical operation, are diagnosed by its abnormal development usually exhibited by the elongation and over-development of the body of the mandible and the partial disappearance of the angle of the jaw. Many of these cases in their incipiency are mesioclusions, which because of non-treatment and non-removal of obstruction to normal respiration

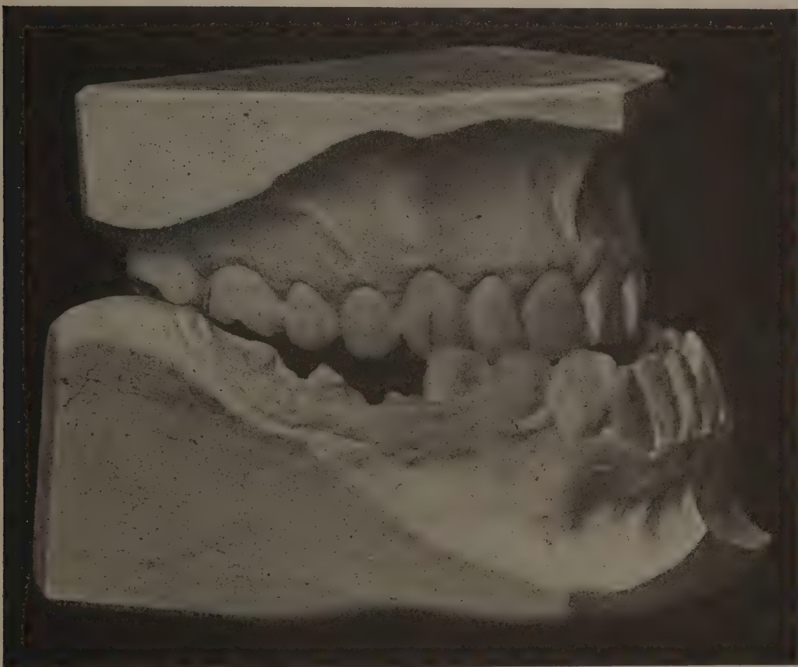


FIG. 944.—Case I. Malformation of the mandible. Right occlusion.

such as hypertrophied tonsils, have followed along the lines of abnormal muscular pressure to such an extent that the extreme of malformation and deformity has resulted.

Treatment of these cases, even after removal of respiratory obstruction, is obviously not along the lines of restoration of normal conditions, espe-

cially in adult cases, but rather that of orthopedic or surgical procedure tending to restore esthetic facial lines.

Case I.—A case, for example, like that illustrated in Fig. 944, presents such difficulties in the way of treatment, that the operation of resection of the mandible for the purpose of securing the best results in improved mastication and facial contour has occasionally been recommended.

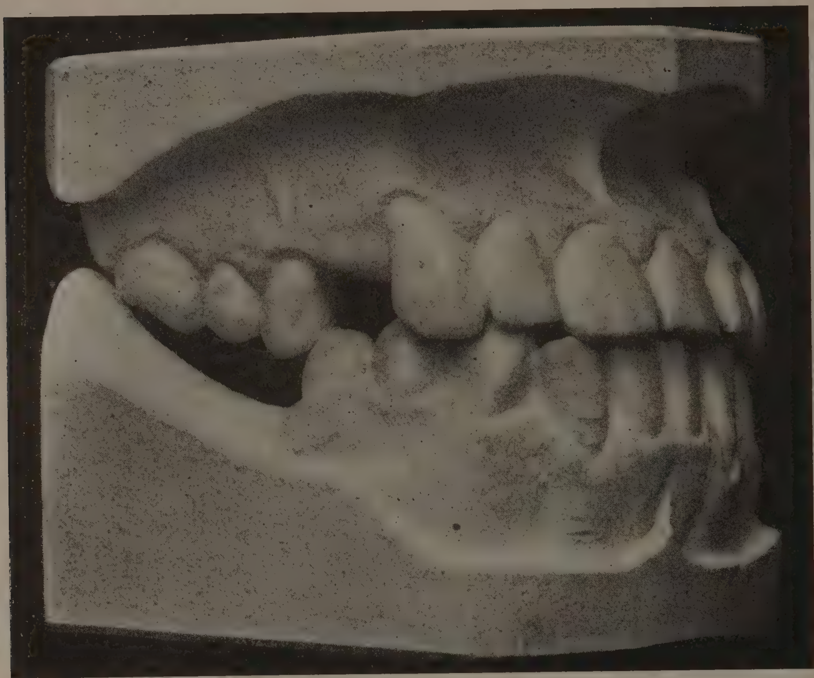


Fig. 945.—Case I. Malformation of the mandible corrected by orthodontic treatment. Right occlusion.

The infrequency of the operation of mandible resection, and the reports of a few failures in the hands of incompetent surgeons, has not aided in making it more desirable. This operation, however, has been successfully accomplished by the general surgeon, and it is believed by the author that it will be more skillfully performed by the trained oral surgeon, especially with the help of the orthodontist.

In the particular case illustrated in Fig. 944, the author performed an orthopedic operation which resulted not only in improvement in masticatory occlusion, but in a transformation of the disfigured facial lines into those of a most pleasing character, besides restoring the function of correct phonation in speaking.

The operation consisted in opening up an artificial space upon each lateral half of the maxilla, between the cuspid and first bicuspid, the width of a bicuspid tooth, moving the six anterior teeth forward to occlusion with the lower incisors, by a conservative use of intermaxillary force and special manipulation of the alignment arches.

At the same time, the teeth in the lower arch were moved distally as far as distal inclination of the lower incisors, and the accompanying

FIG. 946.—Case I. Profile before treatment.

FIG. 947.—Case I. Profile after treatment.

movements of the upper teeth would allow, until the result shown in Fig. 945 was attained. The upper arch was retained by a fixed lingual arch soldered to bands upon the cuspids and first bicuspids, with buccal hooks upon the bicuspid bands, and with elastics extending from these to hooks on lower cuspid bands for a continuation of the intermaxillary force as retention.

Artificial teeth, soldered to the lingual retaining wire, artistically filled up the open spaces until such time as permanent bridge-work could be substituted for the retention.

The improvement in the profile may be seen upon comparison of the before and after treatment pictures in Figs. 946 and 947.

Case II.—Double Resection of the Mandible.—We are indebted to Dr. Max Ballin for the first published illustrations of a successfully operated case of double resection of the mandible, a brief description of which is given here in condensed form.

The patient was a young man twenty-two years of age, who presented himself to the surgeon on May 10, 1907, for possible surgical treat-

ment of a protruded mandible, which orthodontic treatment had for some reason failed to remedy.

The extent of the protrusion measured one-half inch from the labial surfaces of the upper incisors to the lingual surfaces of the lower incisors, and the relations of the two dental arches in occlusion was such that it was almost impossible to masticate the food as illustrated in Fig. 948.

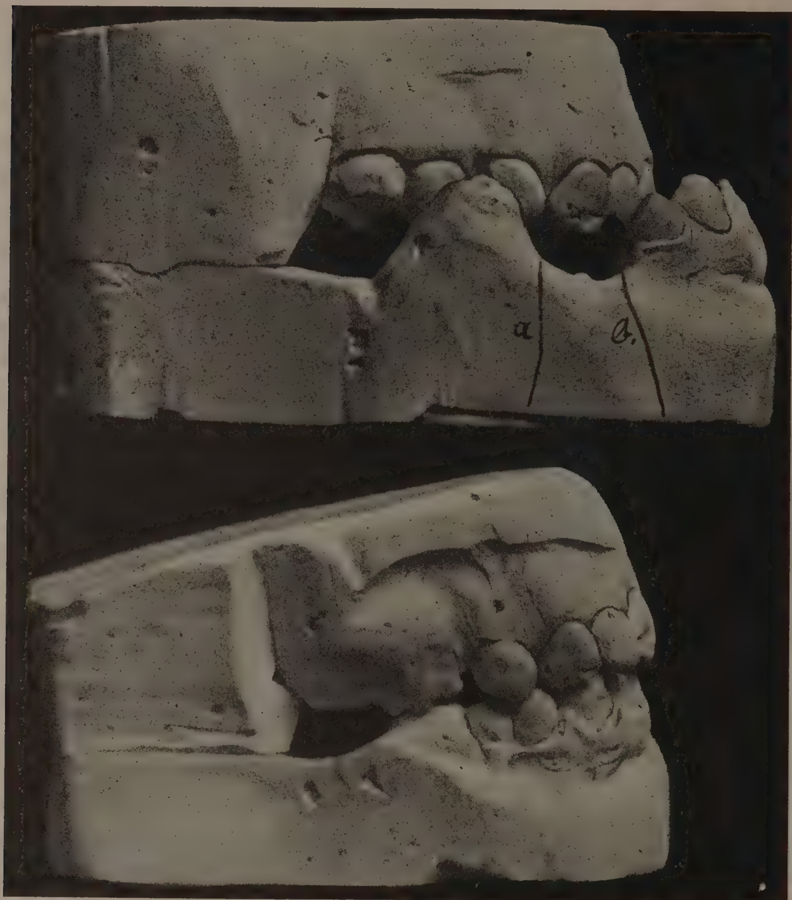


FIG. 948.—Case II. Malformation of the mandible before and after treatment by resection. (*After Ballin.*)

The loss of several teeth from each lateral half of the mandible left spaces in which considerable resorption of the process had taken place, and from which it was thought advisable to cut comparatively uniform sections of the mandible, and readjust and unite the anterior and posterior sections.

Previous to operating, Angle's fracture bands were fastened to the teeth on either side of the area from which the sections were to be cut, by a dentist who was called in consultation. The operation was performed on May 20, 1907, at Harper Hospital, Detroit. Ether was administered, and the incision made in the soft tissues under the lower border of the body of the mandible. The soft tissues were separated from the buccal and lingual surfaces of the bone in the region to be resected, and the mucous membrane was detached from the alveolar process with a curved bistoury, care being taken not to make the slightest entrance into the oral cavity.

A trapezoid shaped piece was then resected from the mandible with a circular saw driven by an electric engine such as is used for trephining. In repeating the operation upon the other half of the mandible, the old

FIG. 949.—Case II. Profile before treatment.

FIG. 950.—Case II. Profile after treatment for resection of the mandible.

style chain saw was found to work much easier and took considerable less time. A Deschamps aneurysmal needle was used to lead the saw around the mandible. The bases of the resected pieces were about one-half inch in length and somewhat longer than the apices.

Holes were drilled through the lower edges of the remaining segments of the mandible, the segments were adjusted together, and silver wires were inserted from one segment to the other on each side. After suturing the external wound, the union of the segments was made more secure by the ligating the buttons upon the fracture bands within the mouth, from the teeth on the anterior segment to those upon the posterior segments.

The entire operation, with the exception of the ligation of the fracture bands, was performed outside of the mouth, so as to make it as aseptic as possible.

The patient made a quick recovery, being in the hospital about one week, the wound healing by first intention. The after-treatment model in Fig. 948 and before and after treatment profiles in Figs. 949 and 950 show a marked improvement over former conditions.

Dr. Ballin remarks: "In the first place, strict asepsis should be a condition without which successful work is impossible. Therefore, opening the oral cavity during the operation should not occur as this would certainly lead to suppuration and non-union of the bones. If the teeth are extracted during the operation, communication between the external incision and the extraction wound will always take place. I would recommend, therefore, to extract the teeth necessary to be removed for the resection, first, and then wait some months until the extraction wound is completely healed and atrophy of the alveolar process has taken place."

In commenting upon this operation, the author believes that Ballin has solved the difficulties in the way of preventing the inception of septic conditions, in operating entirely external to the oral cavity.

One suggestion made by Angle in regard to preparation for this operation seems an improvement in the technique and that is the resection of the previously made plaster cast of the mandible, and readjustment with the upper cast for the purpose of obtaining the best occlusion, and cutting out a section of the mandible which most nearly approximates the plaster section which was removed. In this way, the lines of direction for the chain saw might at least be approximated more perfectly than without any measurements, and the mandible better adjusted for occlusal relations.

In any event, the coöperation of surgeon and orthodontist seems advisable in working out the details of double resection of the mandible in order that the peculiar skill and experience of each may serve the purpose of obtaining the most scientific and beneficial results.

CHAPTER LX

SURGICAL PROCEDURE IN SPECIAL CASES OF MALOCCLUSION

Minor Surgery in Special Cases.—There are certain well defined cases of malocclusion which require minor surgical operations in addition to orthodontic treatment and these usually consist of cases presenting with an abnorma lattachment of the frenum labium, with unerupted supernumerary teeth, or with impactions of permanent teeth, especially the

FIG. 951.—Abnormal attachment of frenum surgically treated and incisors moved together.

cuspids. The operations necessary in these cases, while they are minor ones, require some skill and an accurate attention to detail in technique in order to obtain satisfactory results, and they will be briefly described.

Operation for Abnormal Frenum Labium.—The separation of the upper central incisors through the abnormal lingual attachment of the

frenum labium, extending between the teeth to the lingual tuft in some cases, usually requires the bodily movement of the two teeth together, and their retention for a considerable period, until the frenum assumes a higher position in its growth.

The present methods of treatment of these cases vary considerably; in one case the frenum is partially dissected from its attachment between the central incisors, by making incisions upon either side of it, and cutting it off with a pair of gum scissors slightly above the necks of the incisors, cauterizing the incised wound with the electric cautery; in another case the operation may not be necessary after moving the usually diverging roots of the incisors together and retaining them during a sufficient period of growth.

In either case, the centrals are fitted with bands having the vertical tubes of a pin and tube appliance properly placed nearer the mesial angles of the incisors, and the bands cemented in position. If the centrals need rotating, the tubes may be located nearer the distal angles. A case of abnormal attachment of the frenum labium, before and after treatment by incision and moving the incisors together is shown in Fig. 951.

Fig. 952.—Partial pin and tube appliance for moving centrals together in a case of abnormal attachment of the frenum labium.

A portion of a pin and tube arch wire, .030 in., with vertical pins fitting the tubes on the incisor bands, and a contractile loop in the base wire between the centrals, as in Fig. 952, will serve to move them together, and act as a retainer as well.

The movement of the incisors together occupies but a short period of time, but their retention is a matter of a year's time even in the youngest cases. The two central incisor bands are usually soldered together and cemented in position for the retention of these cases.

It is not necessary to perform the operation of frenum resection in every case presenting with separation of the central incisors, the simpler

and sometimes the more severe cases responding to the treatment indicated of movement of the incisors together, with a prolongation, however, of the period of retention.

Operation for Impacted Teeth.—Impacted teeth, which require surgical interference to effect their eruption, may lie either labially or lingually to the arch line, usually with the space for their eruption in the arch partially or completely closed. If the impacted teeth are in their proper positions in the maxilla, even though unerupted, the development of the dental arch, by providing the full space for their eruption, will usually free them from impaction and they will erupt into their proper positions in the arch without assistance.

When, however, these teeth lie outside of the arch line, laterally or lingually, and especially in cases in which they have assumed transverse positions in relation to their normal eruptive positions, surgical procedure is necessary to provide a direct means of attachment for their movement into the arch line, or in cases of supernumeraries, to effect their removal.

Operation for Labially Impacted Teeth.—The diagnosis of the presence and position of a labially impacted incisor or cuspid is made by locating it with the X-ray taken at several different angles. If it is an impacted cuspid, its position should be carefully located and the appliance, preferably a labial arch wire and molar bands, adjusted so that the crown of the impacted tooth may be later ligated to it. The labial arch wire is then removed, and the tissue overlying the crown of the impacted tooth anesthetized, either by infiltration or conductive anesthesia. Vertical and horizontal incisors are then made in the tissue directly overlying the crown, the location of which has been made with a fine explorer, the enamel surface being distinguished from the bone by the hardness and smoothness of its surface. The opening through the gum tissue is next enlarged by forcing the soft tissues to either side so that the full area of the surface of the crown of the tooth is exposed. The wound may be temporarily packed with gauze which has been dipped in a saturated solution of tannic acid in a compound tincture of benzoin to allay the hemorrhage, after which the gauze is removed, and any bone overlying the crown chiseled off, and the coronal tip of the cuspid freely exposed by further removal of bone with a bone drill.

The usual technique consists of drilling a hole in the crown of the tooth and fitting in a hook which is attached by a silk or rubber ligatures directly to the arch wire. Dr. Dunn has suggested making a cap to fit the tip of the opposite erupted cuspid in the mouth for the tip of the unerupted one by taking an impression of it and getting a cast in plaster from which a Melotte's metal die is made, and the cap swaged. An eye or hook for ligation is then soldered to the cap which is cemented in position.

An improved technique consists of so freeing the tip of the cuspid crown from the bone that a wax impression may be made for a cast gold tip at this time, repacking the medicated gauze in the wound to preserve the opening until the next sitting.

Guttapercha has been found by the author to be much cleaner and more serviceable than gauze, if put in while hot and under pressure, being retained by an auxiliary spring wire from the labial arch wire until the cast cap is ready for cementation. Dr. Varney Barnes has suggested the use of punk saturated with paraffin in place of the guttapercha as exerting less pressure on the impacted tooth, and being healing to the tissues. The guttapercha is removed at the second sitting, the surface of the crown careful dried and kept dry by the assistant while the oper-

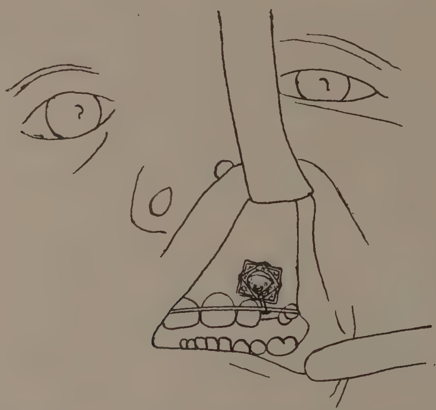


FIG. 953.—Cast gold tip on labially impacted cuspid ligated to alignment arch.

ator spatulates a mix of Ames special crown and bridge cement, places it in the cap and forces it tightly over the tip of the cuspid, holding it firmly in the serrated beaks of a plier until the cement has set.

After trimming away the surplus cement, a softened piece of guttapercha is again placed in the wound until the next sitting of the patient when the eyelet or hook on the cap is ligated with silk or rubber to the labial alignment arch, Fig. 953, and the cuspid gradually erupted into position. The auxiliary spring attached to the labial arch wire may be used to move the cuspid into alignment in place of the silk or rubber ligature if desired.

Operation for the Lingual Impactions of Cuspids.—When the cuspid is lingually impacted, it should also be located by radiograms taken at several different angles, and after anesthetization, two transverse incisions made at right angles to each other directly over the surface of the crown of the impacted cuspid as illustrated in Fig. 954. Dissecting back the flaps from the lines of incision the surface of the cuspid is uncovered and

the flaps held back by an assistant, thus enlarging the opening of the wound and giving a clearer vision of the field of operation as shown in Fig. 955.

As many of these impactions are very deep the necessity for such a procedure is very evident, especially as the operator cannot continuously hold the flaps back and operate on the bone over and around the tooth at the same time.

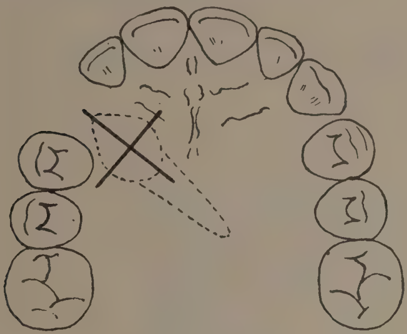


FIG. 954.—Lines of incision for uncovering lingually impacted cuspid.

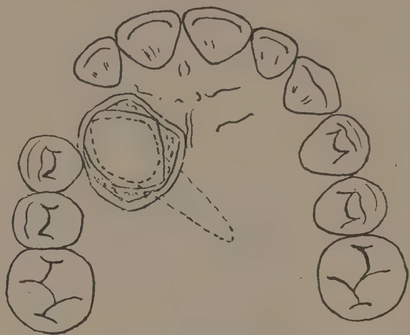


FIG. 955.—Flaps dissected away from field of operation leaving surface of cuspid uncovered.

After the hemorrhage has been controlled with the gauze saturated with tannic acid in a compound tincture of benzoin, the operator should remove all of the bone over the exposed surface of the cuspid with a small bone chisel, and drill away the bone from around the tip of the crown of

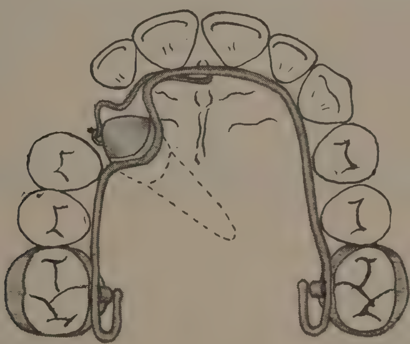


FIG. 956.—Lingual arch with auxiliary spring attached to a ring on a cast cap on an impacted cuspid to erupt and move it into arch alignment.

the cuspid. Following the same procedure as with the labially impacted cuspid, a cast gold cap with a small wire ring attached should be made and cemented into position at the next sitting, packing the wound widely open with guttapercha in the interval between appointments.

The appliance used to move a lingually impacted cuspid into the arch line should preferably be a lingual arch with auxiliary springs, Fig. 956,

which should be made before the operation and placed in position immediately after the operation so as to use an auxiliary spring to hold the guttapercha in place until the next sitting. A ligature may then be attached from the ring on the cast cap to the auxiliary spring until such time as the cuspid is sufficiently erupted to engage the auxiliary spring directly with the ring on the cast cap.

This technique for the eruption of impacted cuspids will apply to any of the anterior teeth which may be impacted and has the advantage of non-

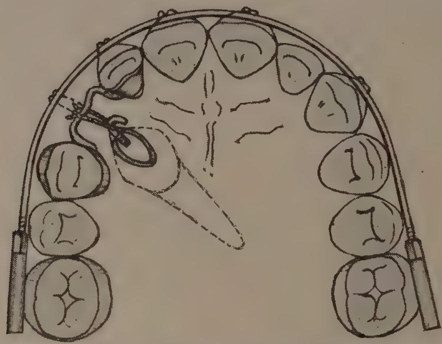


FIG. 957.—Eruption of lingually impacted cuspid by ligating imbedded hook to alignment arch or to wire loop connecting bands on lateral and bicuspid.

FIG. 958.—Upper casts exhibiting lingually impacted cuspids (left) and after their eruption (right).

mutilation of the impacted teeth as in the use of the drilled hole and pin method.

In cases in which the cuspid is too deeply imbedded to construct a cast cap and ring attachment, the auxiliary finger spring on the lingual arch may be used to engage the side of the crown of the cuspid through the hole drilled in the bone until the tooth is brought nearer the surface of the gum, when the cast cap may be made and the lingual arch with auxiliary spring used to move the cuspid into final arch alignment.

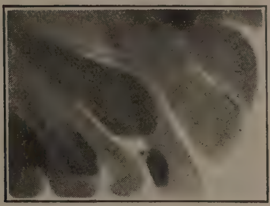


FIG. 959.—Radiogram of impacted upper left cuspid of case shown in Fig. 958.

FIG. 960.—Radiogram of upper right cuspid of case shown in Fig. 958.

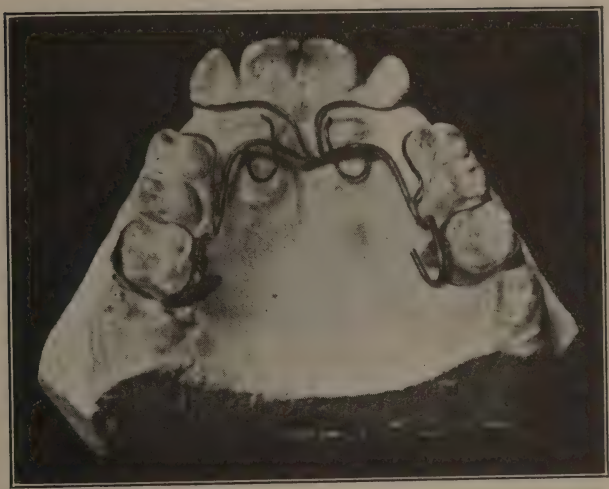


FIG. 961.—Lingual arch used to erupt lingually impacted cuspids.

FIG. 962 A.—Radiogram of impacted right upper cuspid.

FIG. 962 B.—Radiogram of impacted left upper cuspid.

The labial alignment arch may also be used to move a lingually impacted cuspid into arch alignment, especially if this appliance is used to open the space for the unerupted cuspid, which is ligated to the alignment arch by means of an imbedded hook or spring wire as illustrated in Fig. 957.

Fig. 958 exhibits a case before and after treatment in which both the upper cuspids are lingually impacted, the radiograms in Figs. 959 and 960 exhibiting their positions in the arch. A lingual arch with auxiliary springs was ligated to rings on caps on the cuspids as shown in Fig. 961 was used to erupt the cuspids into arch alignment. Fig. 962 illustrates the radiograms of a double lingual impaction of the cuspids in a neutroclusion case, which was treated in a similar manner.

CHAPTER LXI

THE PROBLEM OF EXTRACTION

Extraction and Orthodontic Ideals.—Extraction of the teeth of either deciduous or permanent teeth in orthodontia must be viewed from a different standpoint than in general dental practice, since the whole aim of the orthodontist is the restoration of the dental arches in occlusion with the full complement of teeth, while the dentist is more intent upon the restoration of contour, etc., of the individual tooth, although recognizing the value of arch integrity.

If the general practitioner could see his work through the light of occlusion, articulation and development, all of his cases for bridge-work would be sent to the orthodontist for restoration of normal sized arches, and the regaining of spaces, partially or completely, from which teeth have been extracted.

This radical departure from the older methods of treatment by modern orthodontists in the adoption of conservative methods of treatment, bases its assurance of propriety upon the premises *that in the attainment of the normal and ideal in occlusion, all of the dental organs must be preserved in the correction of malocclusion* if possible.

Such an arbitrary standard is not made by the specialist, but it is indicated by the perfection of the occlusion in the normal and ideal, in which is recognized the value of the individual tooth as a factor in the preservation of the integrity and regularity of the arches of teeth, the loss of one or more teeth from either arch causing deformity to just the degree of extraction which is resorted to.

With this conception of treatment in orthodontia, extraction as a beneficial procedure, that is, towards restoring the normal in occlusion, is of course absurd, for with extraction comes mutilation of the arches, impairment of speech and mastication, and the formation of lines of inharmony in the face which are surely not desirable as a result of the efforts of the orthodontist.

A very large number of the deformed arches of teeth and inharmonious facial lines which are seen on every hand, are caused by the premature extraction of deciduous teeth, or the unwise extraction of permanent teeth.

Results of Premature Extraction of Deciduous Teeth.—A very frequent question asked of the specialist by parents is as to the advisability of extraction of one or more of the deciduous teeth in the mouths of their

children to "make room" for the permanent teeth. The acquiescence by the dentist in the unwisdom of this fallacious and pernicious idea has led to the inadvisable extraction of deciduous teeth in the vain hope that the space thus created will allow the permanent teeth more room to erupt.

The result of such extraction of deciduous teeth, if performed some time before the period for their normal shedding, is just exactly the reverse of that which is intended, for the dental arch instead of being any larger, becomes still smaller through the contraction of the space of the lost deciduous teeth, and the permanent teeth have *less room* in which to erupt than if none of the deciduous teeth had been extracted.

Results of Extraction of Deciduous Laterals.—For example, in the cast on the left of Fig. 963, the deciduous lateral incisors were removed by the family dentist in the belief that the two permanent centrals would

Fig. 963.—(Left) Removal of deciduous lateral incisors in vain attempt to "make room" for permanent laterals. (Right) Arch enlarged by orthodontic means to make space for unerupted lateral incisors.

have more room for eruption, as they were apparently crowding somewhat in their effort to erupt. As a result of this treatment, the centrals erupted almost perfectly in alignment, but it will be noticed that their distal angles are almost in approximation with the deciduous cuspids, and that there is no space left for the eruption of the permanent lateral incisors, necessitating an orthodontic operation for the restoration of these spaces, and the anterior development of the arch as seen in the cast on the right of Fig. 963, the deciduous laterals immediately erupting upon being released from imprisonment.

Results of Extraction of Deciduous Cuspids.—A Class I case, in which the lower deciduous cuspids have been prematurely extracted, with the complete loss of their space and anterior arrest of development in consequence, is illustrated in Fig. 964.

The lower incisors, having lost their support in the cuspid region, have become inclined lingually, and the upper incisors have been forced back against the lower incisors through the pressure of the lips and abnormal function.

The treatment of this case was undertaken at the time it presented with this condition of occlusion, and both arches were developed; in the lower, the cuspid spaces were regained, as shown in the casts at the top of Fig. 965, and in the upper, the centrals were moved forward, and the space

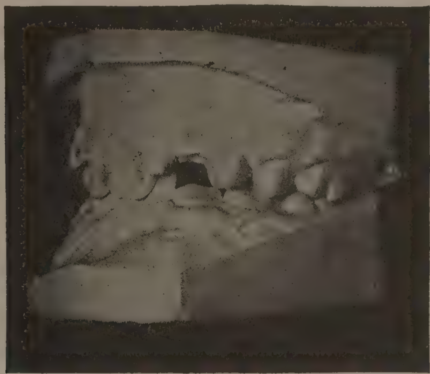


FIG. 964.—Premature extraction of deciduous cuspids.

for the right first deciduous molar regained, as shown in the casts in the lower part of Fig. 965, and this relationship established through proper retention until the eruption of the permanent cuspids and bicuspids.

A very noticeable improvement in the facial lines through this treatment may be seen in the profiles in Fig. 965, showing that the harmony of the facial lines is affected by such apparently slight arrest of development as is caused by the loss of the lower deciduous cuspids and an upper deciduous molar.

Result of Extraction of Deciduous Molars.—The model on the left in Fig. 966 exhibits a case in which the lower deciduous molar was prematurely extracted, the subsequent closing up of its space, and arrested anterior development of the lower arch, with the tipping lingually of the upper incisors in an attempt on the part of nature to obtain a contact occlusion with the lower incisors. The model on the right illustrates the case after the space has been regained for the extracted molar, the arches harmonized anteriorly in occlusion, and a band and bar retention attached from cuspid to first molar in the lower arch, pending the eruption of the permanent bicuspids.

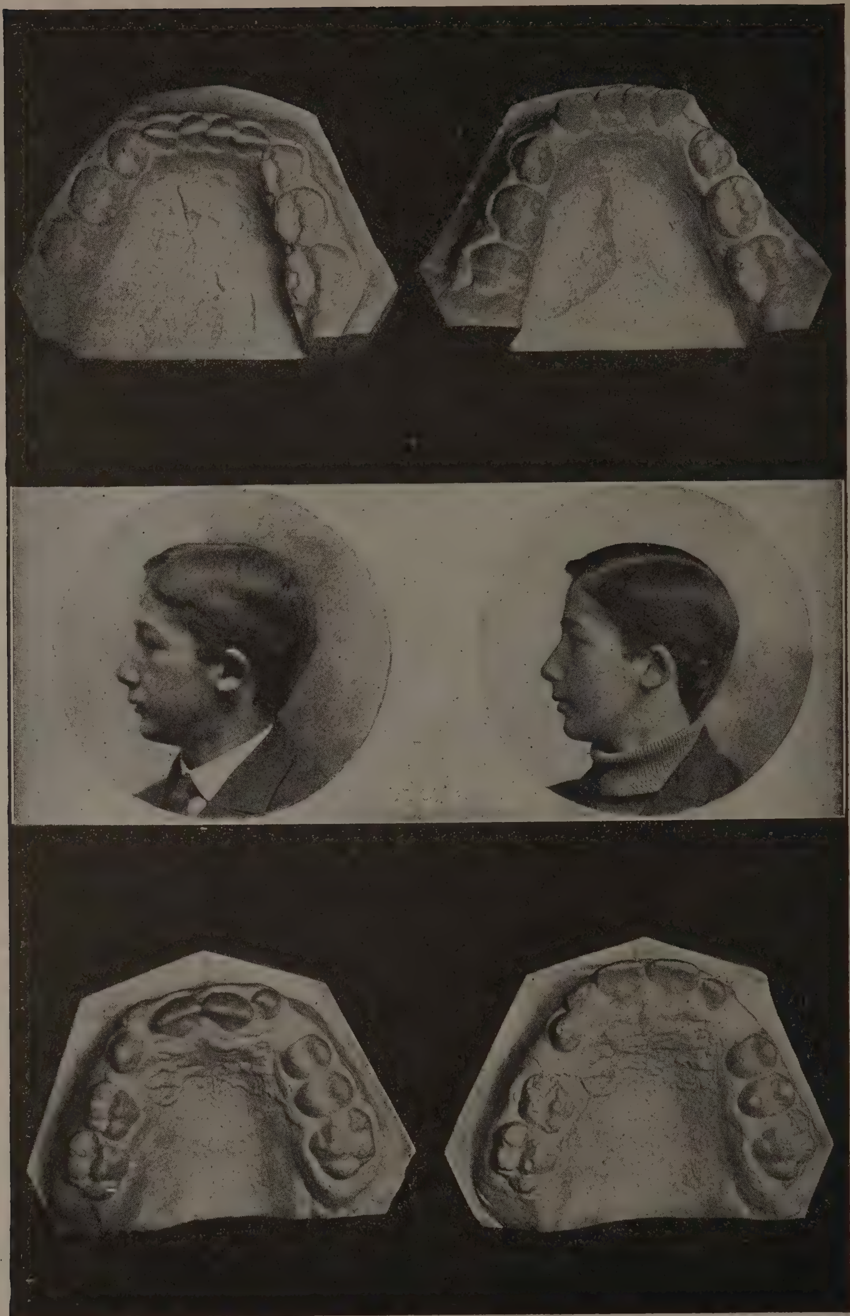


Fig 965.—Upper and lower casts and profiles before and after orthodontic treatnmet of case shown in Fig. 964.

The loss by premature extraction of any of the deciduous teeth has a similar destructive effect upon the occlusion, the difference being only in degree.

Necessary Premature Extraction of Deciduous Teeth.—The author does not mean to discourage the necessary extraction of deciduous teeth which have become deeply carious or abscessed long before the proper period for the absorption of their roots, as the retention of these diseased teeth might cause intense suffering or irreparable harm to the health of the patient.

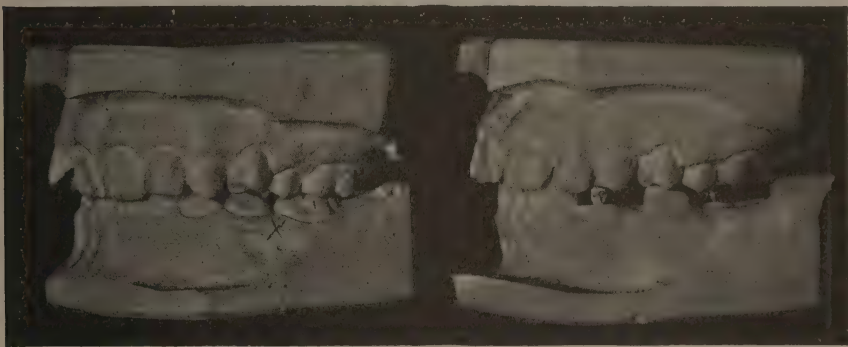


FIG. 966.—(Left casts) Result of premature loss of deciduous molar. (Right casts) After orthodontic treatment of malocclusion shown in the casts on the left.

If carious conditions of some of the deciduous teeth are beyond repair, and alveolar abscess is imminent, extraction of these teeth is always advisable although it is imperative that the space of the extracted tooth be preserved by orthodontic means, the band and spur method shown in Fig. 966 being applicable to almost any case.

Evil Effects of Extraction of Permanent Teeth.—In the loss of teeth by extraction from the second dentition, somewhat similar effects upon the dental arches are observed to those produced by extraction or premature loss of the deciduous teeth.

Successively, the results of extraction of one or more of the permanent teeth are, the destruction of the integrity of the dental arches, the destruction of occlusion and articulation, and finally the marring of the facial lines. The extent of the deformity is usually proportionate to the degree of the extraction, every additional tooth lost causing just that much more aggravation of conditions and change to the abnormal.

Relative Value of First Permanent Molars.—In view of the prevalency of the extraction of the first molars it may be well to consider, first their relative value, and then the result of their extraction from the arch. Some of the more important reasons for their preservation in the arch are as follows.

1. They are the first of the permanent molar teeth to erupt, and during the period of shedding of the temporary dentition, afford the broadest and best masticating surfaces in the mouth.

2. By reason of their great size and strength, they are the only teeth that can serve as a means of preserving the normal relationship between the dental arches, and consequently the symmetry of the face, at a time

FIG. 967.—Result of loss of lower right first permanent molar.

when no other of the permanent teeth, except the incisors, are erupted to occlusion.

3. Their presence is an aid in the forward development of the mandible.

4. Statistics comparing the relative frequency of caries in the first and second molars prove the second molar more often carious than the first.

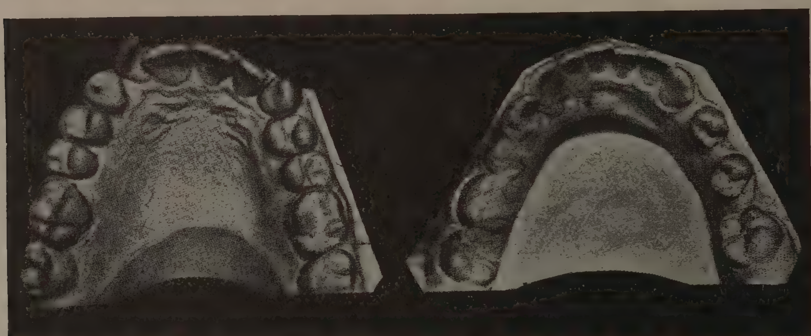


FIG. 968.—Effect on the individual dental arches of the extraction of the lower right first permanent molar in the case shown in Fig. 967.

5. The first molar, on the average, is a better constructed tooth than either the second or the third molar.

6. Its extraction is the cause of large percentage of cases of malocclusion, and consequent facial inharmony.

Results of Extraction of First Permanent Molar.—The history of the case of malocclusion in Fig. 967 dates its inception back to the time of the extraction of the lower right first permanent molar, and the intricate changes in occlusion to the abnormal as a result are commonly observed as the effect of such extractions.

The cast on the right of Fig. 967 represents the left side of the case in occlusion, exhibiting normal cusp relationship of upper and lower teeth as far forward as the cuspid.

The cast on the left illustrates the destruction of occlusion and the shortening of the right lateral half of the dental arch as a result of the extraction of the lower right first molar.

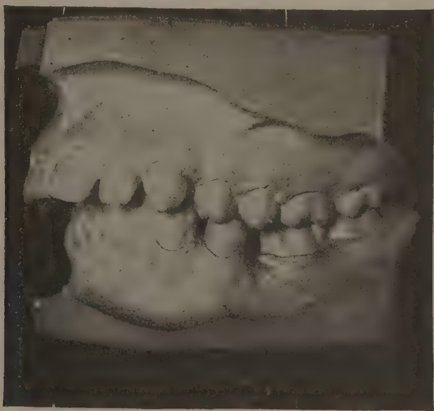


FIG. 969.—Destruction of occlusion through extraction of lower second bicuspids.

To the student of occlusion, the changes in occlusal relations after the loss of the first permanent molar are more or less familiar, and it is comparatively easy to follow the consecutive stages whereby the ruination of otherwise beautiful dental arches has been accomplished.

Consequent upon the loss of the first molar in this case, ensued not only the tipping mesially of the second molar, but also the drifting distally of the second bicuspid into the space, followed by the distal movement of the first bicuspid, the cuspid and incisors, and the contraction of the whole arch.

The effect of this contraction upon the upper arch is noticeable in the lingual positions of the incisors, and the torsion of the right lateral incisor.

The closing together of the teeth in occlusion tends to force the lower right second molar still farther mesially, and to draw the right lateral half of the lower arch distally to a considerable extent.

The occlusal views of the upper and lower arches in this case in Fig. 968, illustrates from this aspect, the mutilated arches, both being contracted

and the upper arch flattened in the incisor region, producing a similar effect in the facial profile, as a consequence.

The author has observed a patient with a similar case of malocclusion, who was on the verge of nervous collapse as a result of such changes in occlusion as to make mastication painful and almost impossible.

Result of Extraction of Second Bicuspids.—A variation from these changes in occlusion as a result of the extraction of a lower second bicuspid

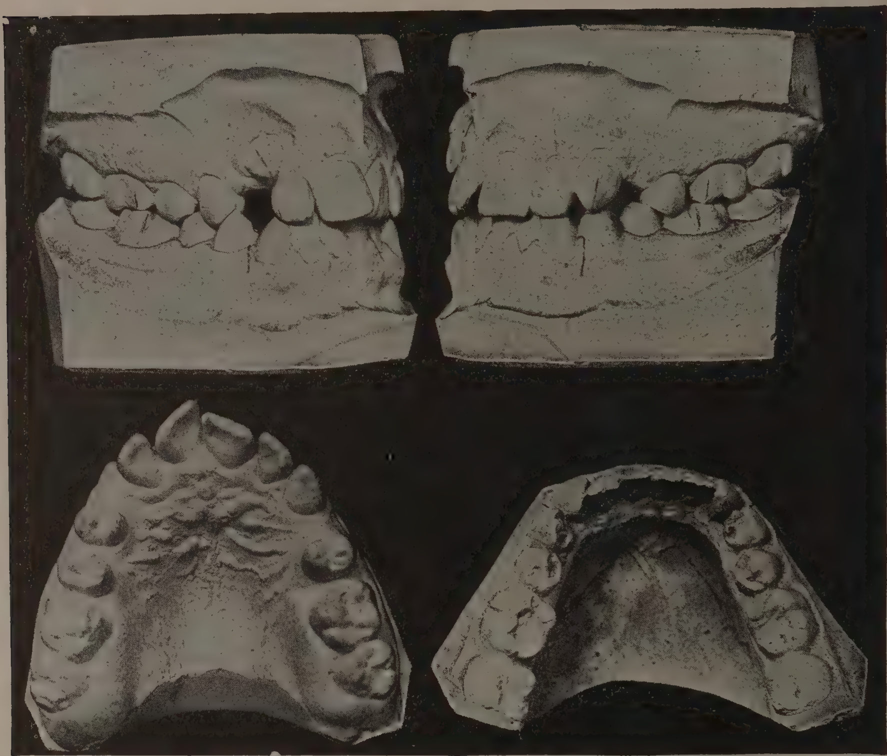


FIG. 970.—Failure of extraction by a dentist of upper left first bicuspid to correct a neutroclusion.

is observed in Fig. 969. Although not revealed by the picture, the second bicuspid on the right side of the lower arch was also extracted so that the change in occlusion was comparatively uniform bilaterally.

The loss of these teeth has caused an apparent protrusion of the upper arch as shown in Fig. 969 as a result of the perversion of function of the occlusal planes and also of the lips, the lower lip tending to roll up under the upper incisors and force them still farther outward.

The first and second molars in occlusion have retained the normal mesio-distal relationship of the arches, and the contraction of the lower

arch has been entirely anterior to the first molars, the second bicuspid spaces being almost entirely closed.

Comparison of Arch Restoration with Extraction and Realignment.—The illustration of a few practical cases in pairs, of the same class, one of the pairs having been treated by extracting, the other by restoration of normal occlusion, may serve, by comparison, to show the relative value of the two methods of treatment.

Fig. 970 exhibits a Class I case in which the dentist, who originally had it in charge, before referring it to the orthodontist, thought it necessary to extract the upper first bicuspid on the left side in order to "make

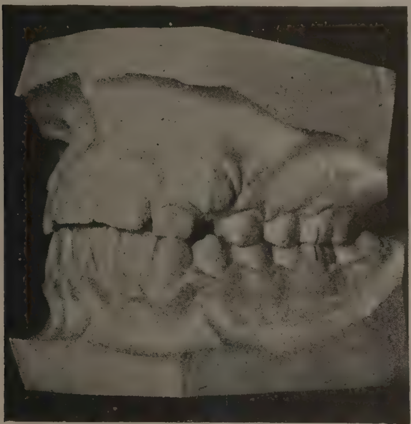


Fig. 971.—Neutroclusion with malerupting cuspid similar to that shown in Fig. 970.

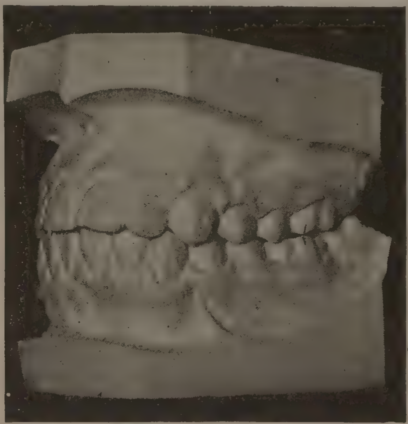


Fig. 972.—Restoration of upper dental arch of case shown in Fig. 971 and eruption of cuspid with arch alignment.

room" for the eruption of the left upper cuspid which was formerly in a position similar to that of the right cuspid seen in labioversion in the model on the left of the cut.

The operation of extraction was performed as indicated, the upper left cuspid erupting into the space, partially, but so incompletely filling it that the patient was unwilling to have the same thing done upon the right side of the arch.

On examination of the occlusal view of the upper and lower casts in the same cut, it will be observed that the lower arch is contracted anteriorly, the cuspids being in torsiversion, and if treatment for development of both arches had been instituted, normal occlusion could have been obtained.

Fig. 971 illustrates a precisely similar case except that the malocclusion is limited to the left lateral half of the arches. The prognosis in cases of this kind is always favorable to treatment without extraction, and the diagnosis assures such splendid results as are shown in the after treatment model in Fig. 972, the arches being restored to normal size and shape, and normal occlusal relations being established.

Fig. 973 exhibits a somewhat more severe case than the one just described, and it might have been governed by the same laws in its treatment if they had been understood.

Fig. 973.—Neutroclusion which was treated by extraction methods. (See Fig. 974.)

Fig. 974.—Resulting malocclusion after extraction of upper second bicuspid in case shown in Fig. 973.

Two mistakes were made in the treatment of this case, however, one by the extraction of the upper second bicuspid, the other the neglect of the slight irregularity in the lower in the treatment of the case. The after treatment model in Fig. 974 shows alignment to a certain degree but it will be noticed that the arch is still crowded, and that the possibility of harmonizing the arches and restoring occlusion is forever lost. All that

Fig. 975.—Neutroclusion with labioversion of cuspid and linguoversion of lateral (upper).

Fig. 976.—Development of normal occlusion without extraction in case shown in Fig. 975.

was needed was the regaining of some lost space in the lower arch and the harmonizing of the upper arch to it, saving all of the teeth.

Fig. 975 illustrates a similar neutroclusion case in which the ideal has been attained in the restoration of normal occlusion without extraction, each occlusal plane having been moved into its correct relationship with its antagonist of the opposite arch, and the production of a harmonious result which is truly beautiful. This result, Fig. 976, was obtained when the principles of occlusion was not well known, and while the exceptions to occlusal restoration are better known and defined at the present time, they do not detract other than by their exception from the principles of normal occlusal restoration as promulgated by Dr. Angle.

FIG. 977.—Unilateral distoclusion in which extraction was resorted to.

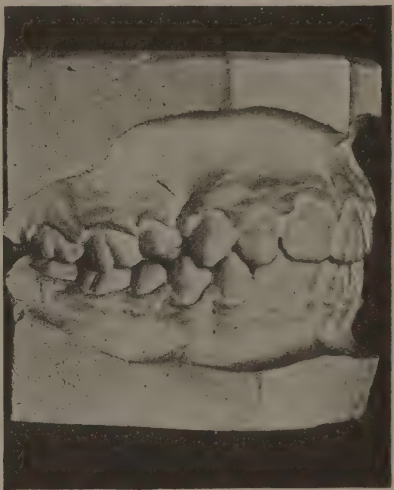


FIG. 978.—Extraction of upper right first bicuspid and destruction of arch integrity in the case shown in Fig. 977.

Extraction in Class II, Div. 1, Subdivision.—Coming now to a case of Class II, Div. 1, subdivision, Fig. 977, another class of deformities in which extraction of the first bicuspid on the side in distoclusion has been advised as of value in the reductions of protrusions such as is here illustrated, let us note in this case the results of such extraction upon the arch. The upper right first bicuspid on the side in distal occlusion was extracted and the anterior teeth drawn distally until the space of the extracted tooth was closed. The model of the completed case in Fig. 978 exhibits no such harmony of contour as the models of the completed cases without extraction which are illustrated under the treatment of the first division of Class II. The curves are not graceful, the mutual support of the full complement of teeth has been lost and a lame and crippled appearance is

distinctly noticeable. The other side of the dental arch being in normal mesio-distal relations was not disturbed. There are adult cases of both divisions and sub-divisions of Class II which respond to treatment by extraction and compensation of occlusion more favorably than the case just described, but it is impossible to foretell the final results of extraction in any case, due to the abnormal action of the forces of occlusion.

In the majority of cases in orthodontia under sixteen years of age, extraction of the teeth is not indicated, in treatment, unless a case is

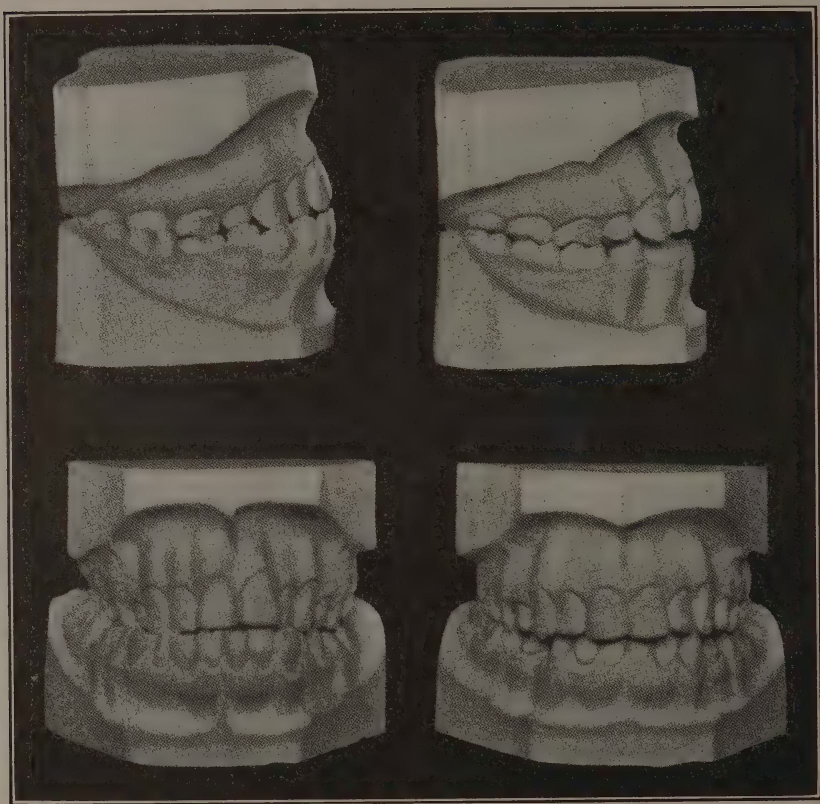


FIG. 979.—A neutroclusion simulating mesioclusion in which extraction of two lower second bicuspids to compensate for the loss of two upper bicuspids proved to be advisable. (*After Dr. L. S. Lourie.*)

already mutilated by extraction when the larger size of the dental arch in which no extraction has taken place, if a Class I case, might necessitate the extraction of a selected tooth in the larger arch to compensate for the tooth extracted from the opposite arch.

While this rule of non-extraction is a safe one to follow in the majority of cases under sixteen years of age, to attempt to practise it in every case

would be entirely unwise, as there are cases in which it is not only impossible to restore normal occlusion, but in which extraction is indicated in order to obtain any sort of harmony or compensation of the occlusion.

Fig. 979, illustrates a case nineteen years of age simulating Class III, from Dr. Louries' practice, and in the extraction of a lower bicuspid on each side and retruding the lower anterior teeth, there is no doubt that the correct procedure was followed, especially as the upper first bicuspids had already been extracted. Opening up the spaces in the upper arch for artificial first bicuspids would have prolonged the treatment and the resulting open bite would have been difficult to close.

Exceptions to the general rule of occlusal restoration in which it is advisable to extract does not give license to extract promiscuously, and the only hesitation which the author feels in attempting to point out these exceptions lies in the possible exaggeration of the number of cases in which the novice, because of his lack of experience, and the unscrupulous dentist, because of his indifference, might feel justified in extracting teeth unnecessarily because of any loophole which the knowledge of an exception to the general rule of non-extraction might give them.

But in the publication of a scientific work on orthodontia, which, to be scientific and most helpful to the general practitioner, should not be misleading, the obligation laid upon the author is so great, that to attempt to encourage the attainment of impossible results through non-extraction and futile attempts at occlusal restoration, would defeat the object of the promulgation of the truth, which should be paramount in the building up of any science which tends in any way to benefit the human race.

It might be correctly stated that extraction and improvement of occlusion is advisable in some adult cases in which normal occlusal restoration could not be advised on account of the mature age of the patient, or in some few cases in which it is impossible to obtain a satisfactory result after an intelligent and persistent effort in following out the laws of occlusal restoration.

Or, in cases of monstrosities of tooth dentition, such as an extreme hypertrophy of the alveolar processes, where restoration of normal occlusal relations would only exaggerate the deformity and increase the inharmony of facial contour.

In cases already mutilated by extraction, in which it is not advisable to restore normal occlusion by regaining all spaces lost by such extraction, it may be necessary to extract according to the requirements which are peculiar to the individual case, and for which no set rule may be established.

Some cases present to the orthodontist with badly carious first molars which are impossible to treat and restore in contour, and which it is advisable to extract. In these cases, if appearing before the eruption of the

second molar, the latter may erupt into the first molar spaces without assistance. In other cases, however, the second molar being already erupted, it will have to be moved by intermaxillary force into the space of the extracted first molar.

These exceptions do not necessarily lower the standard of perfection which the restoration of the normal or ideal in every case might imply, since their very existence and the difficulty of their diagnosis should, in the nature of things, compel the operator to use his best judgment and follow a safe rule.

Although one may be certain of the advisability of extraction in some cases, to lay down a set rule for such cases would militate against the best results which might be obtained without extraction, for in two identically similar cases, extraction may be found necessary in one, while in the other, the restoration of the ideal in occlusal harmony may be easily prognosed and obtained.

So seldom is extraction indicated that in the author's practice, it has been resorted to in but few cases in twenty-two years, and a similar record will be found in the practices of other specialists operating from a conservative basis.

In those cases in which there is any doubt as to the advisability of extraction, the advice of a specialist of at least five years' experience in orthodontia ought to be sought, in order that an error in judgment may not be made through simple lack of experience.

CHAPTER LXII

RETENTION

Structural and Functional Relations of the Dental Arches Immediately after Treatment.—There comes a period upon the completion of active orthodontic treatment when the dental arches have reached their full development for the age of the patient, the malocclusions of individual teeth corrected, when occlusal and muscular functions have been apparently restored, and when *active treatment* must cease, and *passive treatment* be substituted.

Maintenance of Arch Form and Function after Treatment.—This period of passive treatment is known as the "period of retention," which signifies the maintenance of the normal form of the dental arches, their relations to each other, and the normal positions of individual teeth formerly in malocclusion until such time as the natural function of occlusion, together with normal balance of the muscles of the jaws and in some cases, normal respiratory function, is sufficiently established so that these normal relationships of structure and function are alone sufficient to ensure permanence of the results obtained.

Retention may thus be defined as *the maintenance of such development of the dental arches and normal occlusal relations as may have been established during active treatment by the continued stimulation of the functions of occlusion and of the muscles attached to the jaws, aided by the mechanical antagonism of any forces which may interfere with these normal structural and functional conditions.*

Hence it is that retention is really a passive or at least a less active stage of treatment, and success in treatment is only assured when retention is carefully provided for.

In malocclusion there is not only abnormal function of occlusal inclined planes of cusps, but often deficient respiratory mechanism, and tongue or lip insufficiency, and abnormal muscular pressure, which, if not corrected during treatment, will still continue their abnormal influence upon the arches of teeth during treatment during retention.

The Scope of Retention.—A clear perception of the scope of retention necessitates a proper understanding of the ultimate purpose of the treatment of arrested developmental conditions in the dental arches, which is the *restoration of function*, through the stimulation of structural develop-

ment in the maxillary arches, and the attainment of the normal functions of occlusion and articulation, and of the muscles of the jaws.

It will be rightly inferred from this statement that the development and restoration of the normal in shape and size and relationship of the individual dental arch, and the attainment of normal positions of inclined planes of antagonizing cusps of occluding teeth are the primary, and the restoration of the functions of the jaws and attached muscles the secondary consideration in treatment. These two phases are so related, however, that the consideration of the one without the other would be incomprehensive of the scope of orthodontia.

The growth of structure usually follows as a direct result of function, but in orthodontic treatment with its present limitations, the growth of undeveloped dental arches is first stimulated by the gentle force stimuli of mechanical appliances until such time as the restoration of normal arch form and occlusion makes the normal function of the jaws a possibility, when further growth of the dental arches takes place as a result of the continued full function of occlusion, aided by a similar functioning of the muscles of the jaws.

Physiological and Mechanical Phases of Retention.—The end of active treatment, however, is only the beginning of the attainment of the full functions of the occlusion and of the musculature of the jaws, and the passive treatment of the retaining period has as its aim the *physiological* strengthening of these functions up to their full vigor, and the *mechanical* retention of arch form, size, and relationships, and individual tooth positions until the forces of occlusion and the full normal functions of the teeth and of muscles of the jaws insure the permanence of the results attained. There are, therefore, two phases of retention, the *physiological* and the *mechanical*, which should receive consideration separately and together in order that a proper perception of their interdependence may be made clear.

Physiological Phases of Retention.—The physiological phases of retention are embodied in a consideration of normal muscular action, the forces of occlusion and allied functions, and of normal cell metabolism, which will be briefly described in this connection.

In order to clearly present these phases of retention the attainment of the normal in occlusal relations must be considered as the culmination of all the forces exerted in all the functions concerned with the dental arches.

For example, the normal structure of the dental arches and the normal relations of occlusion may be said to be the result of all of the stresses brought to bear upon the teeth and dental arches during their development. Such forces as the action of the muscles of mastication, respiration, degluti-

tion, and even the effort of the muscles concerned with speech and expression of the face have each their effect upon the development of the dental arches through the various forces exerted by them upon the teeth and dental arches.

Sustaining of Normal Muscular Tonicity and Action.—Thus it is that a deficiency in the muscular tonicity of any one group of these muscles requires their training and development up to the point where their restored muscular tone and activity so harmonizes with the other groups of muscles, that the proper muscular balance is secured, and the proper balance of force exerted upon the teeth and dental arches, necessary for the permanence of normal occlusal relations.

Training these muscles with deficient tone and overcoming abnormal muscular habits during treatment often may extend into the period of retention until normal habits have become habitual, and until the recently developed structures surrounding the teeth in their newly attained relations of normal occlusion have become strong enough, through added growth and use, so that coördination between function and structure is sufficient, and further training and observation is unnecessary.

Occlusal Forces in Retention.—Normal occlusal relations in themselves, through the *harmony in the size of the dental arches*, *the normal proximate contact*, and the *influence of the inclined planes of the cusps* of the teeth in the newly acquired relations of normal occlusion, are the natural physiological as well as mechanical forces of occlusion which are valuable in retention in preserving the integrity of the dental arches.

Allied Functional Forces in Retention.—Again, the allied function of normal respiration must be considered as an important factor in retention, for unless it is present, the otherwise abnormal respiration with the habit of mouthbreathing and abnormal atmospheric pressure, and consequent derangement of muscles, will prevent the attainment of successful results in treatment and retention. The value of continued muscle training during retention added by exercises for perfecting normal respiration, especially after rhinological treatment, can not be over estimated.

Normal Cell Metabolism a Factor in Retention.—One of the important factors or physiological forces in retention as well as in treatment has been very aptly termed by Dr. Dewey as *normal cell metabolism*, meaning normal physiological function and growth of the individual cell, not only in the tissues surrounding the teeth, but also in the body as a whole. The interference with normal cell metabolism from lowered vitality caused by diseases such as rickets, etc., has its effect through out the whole body, and in these cases of faulty metabolism treatment will be only partially successful, and the influence of lowered vitality will be observed in the partial failure of retention from a physiological standpoint.

Added to these untoward influences the possible abnormal habits of mouthbreathing, thumb and lip sucking, and the abnormal action of the muscles of the tongue, lips, and cheeks, as well as the abnormal influence of the inclined planes of the cusps in many cases, and it will be seen that the forces which tend to resist normal development and function may be considerable.

Mechanical Phases of Retention.—In order to properly retain the newly developed structures of the jaws after treatment, to support the teeth in normal occlusion, and to sustain the normal functional forces after treatment, it is necessary to provide for a period of mechanical retention of the teeth themselves, in the way of retaining the arch forms, and sizes the relationship of one arch to the other, and the normal positions of individual teeth which have been moved.

The tendency of teeth to partially return to former positions of malocclusion without a period of mechanical retention is of frequent occurrence, and it is necessary to antagonize these return tendencies, either by the use of passive mechanical resistance, or by the continued gentle application of force.

The establishment of mechanical resistance to these return tendencies, through appliances attached to the teeth, must be sufficient so that an equilibrium between the forces of reaction and the applied resistance is obtained. An insufficiency of resistance in a retaining appliance would result in a partial return of former conditions.

Retention, then, as in anchorage, is partially a measure of resistance values, the proper appreciation of which is essential to the permanence of results obtained in treatment.

It is a well known fact in orthodontic practice that a partially fixed retention, *i.e.* the retention of the teeth so that they may have the greatest individual freedom for functionating, is conducive to the best results in the attainment of the full function of the dental arches during retention.

To the end, therefore, of shortening the time of retention, as well as obtaining a more perfect development and greater strength of the tissues surrounding the moved teeth, and avoiding the possibility of any loss from the contraction of the dental arches after development or regaining of spaces, a mechanical retaining appliance, with the fewest number of cemented bands, is generally to be preferred.

Classification of Retention.—Retention may be classified as follows: *Occlusal, simple, reciprocal, intermaxillary, and occipital*, according to the quality of resistance used in opposing the reactive forces, or the return tendencies.

Of especial importance is the influence of the inclined planes of the cusps in retention, one of their normal functions in occlusion and articulation being to preserve the integrity of the arches.

Occlusal retention *is the maintenance of the normal occlusal positions of the teeth, individually or collectively, through the normal functional influence of the inclined planes of the cusps, and the contributory forces gained through restoration of arch integrity.*

In order to secure the harmonious working of the inclined planes it is necessary that not only should the full complement of teeth be present, preserving individual arch integrity by proximate contact, but that the normal size and shape of the dental arches be restored, which would include the restoration of articulating planes and compensating curves, etc. Experience will prove that articulating planes can be only approximately obtained in the correction of malocclusion, so complicated is the mechanism of articulation, and the lack of development of the arches in malocclusion so disturbing the harmonious working of the laws of articulation that accurate opposing cusp contarcts in articular movements is outside the range of possibility of treatment, except in favorable cases.

The nearer the approach to normal occlusion and articulation in the treatment of any case of malocclusion, the less need will there be for mechanical retention beyond that afforded by the normal action and reaction of the inclined planes of the cusps.

It must be remembered however, that the restoration of the normal functions of occlusion and articulation does not at first counteract the tendency of the tissues surrounding the teeth to assume their former relations of abnormality, except to a slight degree, otherwise there would be very little need for mechanical retention of teeth and arches.

Necessity for Mechanical Retention Except in Simple Cases.—*The normal relations of the occlusal inclined planes in the attainment of normal occlusion, cannot be depended upon alone for retention, until after varying periods of fixed retention of the teeth and dental arches with mechanical appliances, except in simple and special cases.*

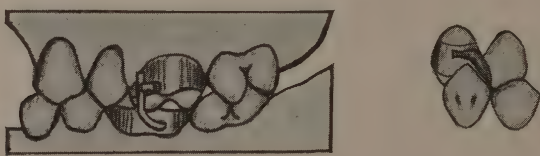
An example of a simple case needing no mechanical retention would be an upper incisor tooth moved from lingual to normal occlusion which, if there is sufficient overbite, would be retained by the action of the lingual incline of the upper incisor upon the labial incline of the lower incisor. The same effect will be observed where there is sufficient overbite in any of the upper teeth which have been moved into their line of occlusion from linguoversion and restored to the normal action of the inclined planes. Fig. 980 illustrates *occlusal retention* in a case of neutroclusion, the inclined planes of the incisors serving as a natural retention of the two incisors which were in linguoversion.

To a lesser degree, also, the normal positions of upper bicuspids and molars in buccoversion, lower incisors and cuspids in labioversion, and lower bicuspids in linguo- or bucco-version, will be retained by the restoration of the normal influence of their inclined planes in occlusion. Infraversion of the teeth, on the other hand, demands long and persistent mechanical retention of corrected occlusion.

Fig. 980.—Occlusal retention.

Again, teeth which have been rotated, unless at a very early age, as during their eruption, will need retention by mechanical appliances for varying periods of time.

Also, anterior and posterior development of the dental arches will usually need mechanical retention for periods of time varying according to the degree or extent of the development, the age of the patient, the peculiarities of the case, etc. Furthermore, extensive cases of Classes II and III, will always demand a very persistent mechanical retention, often



A B

Fig. 981.—Auxiliary occlusal retention. (*After Angle.*)

for several years, although simple cases of Class II, especially of the second division, and its subdivision, and of Class III, are often retained by normal cusp influence alone, as far as the mesio-distal relations of occlusion are concerned after the muscles of the jaws have been restored to full function.

Auxiliary occlusal retention *is the maintenance of the normal occlusal relations of the individual teeth, or of the dental arches as a whole by means of auxiliary occluding inclined planes of artificial cusps, or spurs and planes.*

Examples of *auxiliary occlusal retention* are seen in the auxiliary cusps on cuspid bands for retention as at B Fig. 981, the lingual inclined planes

on upper incisor bands, or on lingual arches, and the spur and plane retention of Class II as shown in Fig. 981A.

Simple retention *is the antagonism of the forces of reaction by the resistance of one or more teeth in the same arch which afford a comparatively stable resistance in opposition to these forces.*

FIG. 982A.—Incisor in linguoversion. B—Band and spur retention of incisor after treatment.

For example, in Fig. 982, A, the central incisor which is in linguoversion is retained in corrected position by cementing upon it a band with a labial spur extending over the labial surface of each adjoining tooth as shown at B in the same figure. The adjoining teeth may have shared in a general labial movement to a slight degree, but would still afford a comparatively stable resistance for retaining the lingual tendency of the central incisor which was in lingoversion.

A torsi-mesio-version of the one central may be retained by the cemented band and lingual spur over the lingual surface of the other central which may, or may not have been moved to a slight extent labially or lingually. An absolutely stable resistance in single tooth movements is, of course, to be preferred for retention purposes.

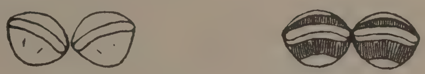


FIG. 983.—Simple reciprocal retention.

Reciprocal retention *is the counterbalancing of the return tendencies of two or more teeth in the same arch or in opposite arches by the antagonism or opposition of their reactive forces.*

Simple reciprocal retention would be represented by the antagonism of the reactive tendencies of two teeth which have been moved in opposite directions, as illustrated in Fig. 983, the two centrals being rotated in opposite directions, and the retention consisting of two bands soldered together, and cemented upon the centrals.

Another example of simple reciprocal retention is illustrated in Fig. 984, the lateral incisor and first bicuspid being reciprocally antagonized in their return tendencies by the band and spur method.

Compound reciprocal retention would be represented by the antagonism of the tendencies to return of several teeth in the same or opposite arches.

In Figs. 985, 986 and 987 are illustrated various methods of securing *simple* and *reciprocal* retention. For example, in B, Fig. 985, the rotating

tendency of the central incisor may be antagonized after correction by *simple retention* by means of labially and lingually placed spurs on a cemented band as in C, Fig. 985. In D, Fig. 985, the tendencies of the mesial angles of the two centrals to rotate in opposite directions may

FIG. 984.—Reciprocal retention.

be counteracted by *simple reciprocal retention* as in E, Fig. 985, by a spur from the mesial angle of one central band to the other, *simple retention* would be here represented by the labial and lingual spurs extending from the central bands to the adjacent laterals. At F, Fig. 985, is shown a varia-

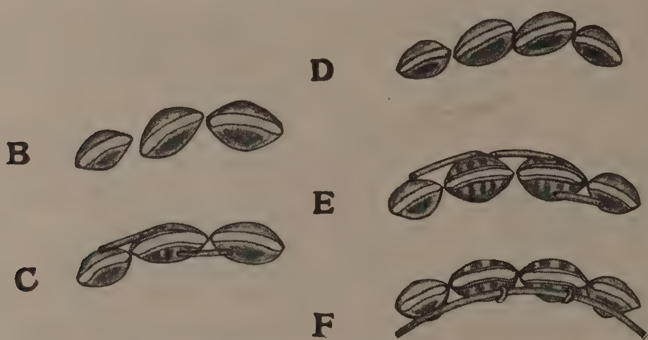


FIG. 985.—Simple and reciprocal retention.

tion of *simple retention* in the use of spurs from the central bands bent over a lingual arch, as suggested by Dr. Lourie.

Fig. 986 exhibits at GH and KL the application of *compound reciprocal retention* by the use of bands and spurs. In the drawings M and N, Fig. 987, *compound reciprocal retention* is illustrated in the use of spurs from the central incisor bands attached to a lingual arch, which assists in retaining the lateral incisors at the same time.

Intermaxillary retention may be compound reciprocal retention between teeth of opposite arches when properly provided for.

In the retention of lateral and forward development of the arch, as in Fig. 991 the resistance of one lateral half is pitted against that of the other, and is an illustration of *compound reciprocal retention.*

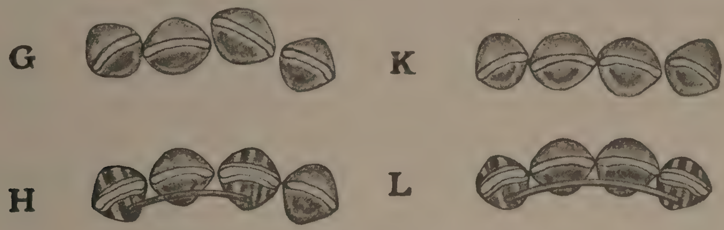


FIG. 986.—Compound reciprocal retention.

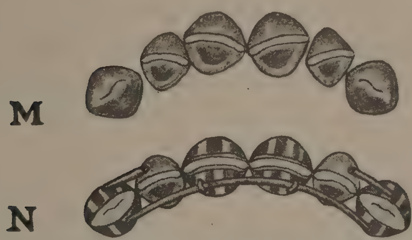


FIG. 987.—Compound reciprocal retention.

Intermaxillary retention *consists of the continuation of the use of intermaxillary force in cases of mesial or distal shifting of occlusion in such a manner that a reciprocation of force and resistance is established which is capable of the retention of the mesio-distal changes in occlusion.*

In adult cases or in "mixed dentures" of Class II or III, the necessity for the use of the intermaxillary force for a considerable time after treatment, in order to retain the normal mesio-distal relations of the dental arches, or the restored occlusal planes, is evident to the experienced orthodontist. This form of retention is especially applicable in cases of the first division of Class II and in Class III. Intermaxillary retention is also of great value in upper protrusions of Class I.

Occipital retention *consists of a continuation of the wearing of the headgear and traction bar or chin cap, for counteracting the resistance offered by the lower dental arch or the mandible, after treatment of mesioclusion or of infraversion with occipital force and anchorage.*

Occipital retention is seldom used except in cases in which the chin cap has been used in connection with it for correction of severe cases of mesioclusion or of infraversion of the anterior teeth. After the use of the headgear for treatment in Class II or Class III, intermaxillary

retention is usually substituted as being sufficient to retain the mesio-distal changes in occlusion.

Field of Mechanical Retention.—In the simpler cases of malocclusion where the dental arches are in normal mesio-distal relation, the dental arches being fully developed, and the overbite normal, the retention of corrected slight malpositions of individual teeth is all that is necessary. The usual case, however, presents with a complication of malocclusions, necessitating retention of developed arches and individual tooth malpositions, often with infraversion or supraversion, requiring a change in the occlusal plane and its retention, and occasionally still further complicated by a distal or mesial malocclusion requiring particular methods of retention.

In general, then, the field of retention may be divided as follows: (1), The retention of corrected malocclusions of individual teeth; (2), retention of developed arches; (3), retention of changes in the occlusal plane (4), retention of mesial or distal changes in occlusion.

Retention of Malocclusion of Individual Teeth.—In the retention of malocclusions of individual teeth, the age of the patient and the length of time the teeth have been in malocclusion must be considered. Incisors moved from lingual to normal labial positions need no retention other than the *occlusal retention* of the cusps. *Occlusal retention* may also be depended on for the retention of cuspids, bicuspids and molars moved from lingual occlusion to normal if the malocclusion is not one of long standing. Teeth which have been erupted but a few months, such as incisors in torsal occlusion, need but a few weeks' retention.

In more advanced cases in which the permanent teeth are all erupted, corrected lingual positions of incisors in Class I need only natural *occlusal retention.* Corrected torsal positions of incisors in these cases, however, need a persistent *simple* or *reciprocal* retention as in Figs. 983 and 985 for at least one year.

FIG. 988.—Retention after bodily movement of anterior teeth.

Retention after Bodily Movement of Teeth.—Again the retention of teeth which have been moved *bodily* must be of a different nature than that of teeth moved by *inclination* movement. At the present writing the best method of retention after bodily movement of teeth is a continuation of the wearing of part of or all of the appliance which was used to effect the bodily movement.

In some cases the author has used a portion of the .30-in. arch wire with vertical pins locking in tubes as in Fig. 988 to retain the positions of the four incisors which have been moved bodily. Various combinations of this nature will suggest themselves to the operator.

Retention of the Developed Arch.—The age at which treatment is begun, and the number of permanent teeth erupted, will necessarily require a variation of forms of retention according to the demands of the individual case.

If uniform development of the dental arch has occurred during treatment, that is, the arch being developed in the molar as well as the cuspid and bicuspid region, the retention will have to be so applied that this development will be uniformly retained. In many cases, however, only the anterior portion of the dental arch needs developing, hence, the retention of the entire dental arch is unnecessary.

The earliest indication for retention in the deciduous arch is after a certain amount of development of the anterior portion of this arch for securing growth enough for the eruption of the incisors and cuspids, and possibly the bicuspids. The need for a partially fixed retention of part of the deciduous arch, during a varying period of natural development and including the eruption of some of the permanent teeth is therefore apparent.

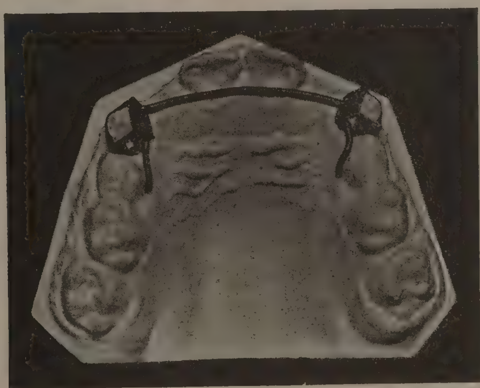


Fig. 989.—Retention of anterior portion of developing arch.

Retention of Anterior Part of Developing Arch.—An appliance which will effectually retain the anterior part of the arch during the developing period and which is attached entirely to the deciduous teeth, is shown in Fig. 989, being the retention of the anterior part of the upper dental arch shown in Fig. 798.

The deciduous cuspids are banded and connected by a lingual wire of .030 inch in diameter and short spurs are extended distally from the lingual surface of the cuspid bands upon the lingual surface of the deciduous

molars. A great amount of strength in a retaining appliance attached to the deciduous teeth is never necessary because of the slight resistance they offer to the action of force appliances in their movement, due to their small short roots, and the cartilaginous nature of the alveolar process.

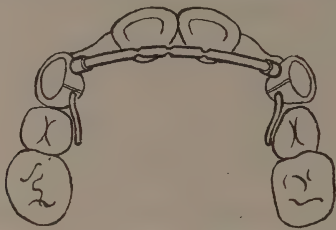


FIG. 990.—Active retention with pinched wire.

If more development of the anterior portion of the arch is required after the development has been carried on as far as possible, the retainer may be constructed as in Fig. 990, in which the lingual wire slips into short tubes soldered to the cuspid bands or is directly attached with solder, and by pinching with the wire stretching pliers, as suggested by Dr. Angle, the arch may be still further developed in this region during the period of retention. The lingual wire in this case should be constructed of platinized gold sufficiently soft to be easily stretched in this manner without breaking.

Retention of the Entire Deciduous Arch.—In case that the deciduous arch has been uniformly developed anteriorly and posteriorly, an immediate need exists for the retention of all the increased width and length of the arch which has been gained in the treatment.

To illustrate, the upper arch in Fig. 991, although the permanent central incisors and first molars are present, is still the same in width as the deciduous arch, and in development is still a deciduous arch.

Having been developed during a period when the deciduous teeth present were comparatively firm in their attachments, the crowns of the permanent teeth being moved laterally through their envelopment by the roots of the deciduous molars, the indicated retention in the case is a fixed retention of the entire deciduous arch until such time as the natural developmental processes have been completed so that the eruption of the remaining permanent teeth may take place in a sufficiently enlarged arch.

According to these indications, the retention exhibited in Fig. 992 was adjusted, bands of iridio-platinum being fitted to the deciduous cuspids and second molars, and connected by a lingual retaining wire of 19 gauge iridio-platinum soldered to their lingual surfaces, and extending across the lingual surfaces of the first permanent molars.

In order to secure a more accurate fit, the lingual wire was adjusted and soldered to the bands upon the plaster cast, the bands having been

removed with the impression. The central incisors were retained with two iridio-platinum bands united with solder, and cemented in position. A slight lateral spring may be given to the lingual retaining wire to assist in further stimulus to lateral development of the arch if necessary.

Retention of Anterior Portion of Permanent Arch.—Where the permanent arch has been developed anteriorly, it is essential that the increased width of the arch should be retained for some time, so as to allow the development of the alveolar process and the overcoming of the forces of reaction. For example, if the arch has been developed anteriorly to allow

Fig. 991.—Retention of entire deciduous arch and mixed denture.

the centrals or laterals to be rotated, etc., the retention of these individual teeth in their lines of occlusion is not sufficient in most cases, as the reactive force in the contractive tendency of the arch will soon cause a malocclusion to appear, such as the overlapping or torsion of one or more of the incisors.

It is advisable, therefore, to always retain the arc of the six anterior teeth by means of a fixed retaining appliance which will hold the width gained between the cuspids, such as is shown in Fig. 992, adding a lingual spur to the second bicuspids when they have also been included in the lateral development.

Fig. 993 illustrates the development and retention of the anterior portion of an upper arch, in which space was made for the eruption of the

cuspids. Bands were cemented upon both of the first bicuspids, these bands having previously been united with the strong .030 inch wire of platinized gold extending along the lingual surfaces of the incisors and having spurs of .020 inch wire bent around the distal angles of the lateral incisors to the labial surfaces to hold the four incisors intact.

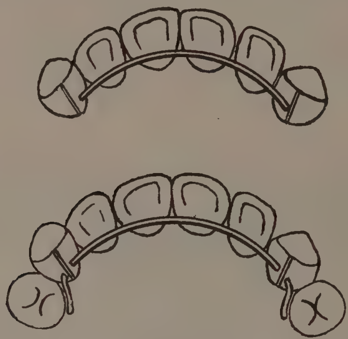


FIG. 992.—Retention of anterior portion of dental arch with fixed retainer.

This appliance is as simple and esthetic as can possibly be constructed for a case of this character, and it might well be used as a standard retention for similar cases in which no rotation of teeth is necessary in the incisor region.

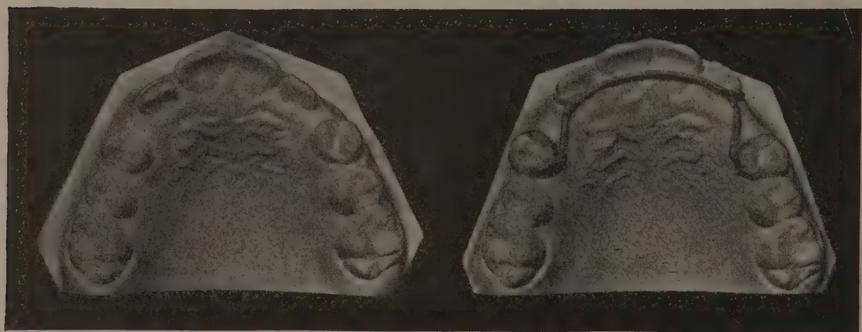


FIG. 993.—Retention of anterior portion of dental arch, preserving space for eruption of the cuspids.

The Lingual Arch Retainer for the Entire Permanent Arch.—The use of the lingual arch retainer, as suggested by Dr. Lourie, invites many possibilities of practical and esthetic retention of the dental arches, because of its efficiency and inconspicuousness.

In its early form it consisted of a gold and platinum or an iridio-platinum wire closely adapted to the lingual surfaces of the incisors, cuspids, and bicuspids, and attached distally to the ends of the lingual

screws or lingual surfaces of molar or bicuspid clamp bands. In its later construction it is attached to the lingual surfaces of plain bands, and it provides for complete retention of the entire dental arch after general development, at the same time providing for such retention of the individual teeth as may be necessary. Fig. 994 illustrates the modern form of fixed lingual arch for retaining the development of the permanent dental

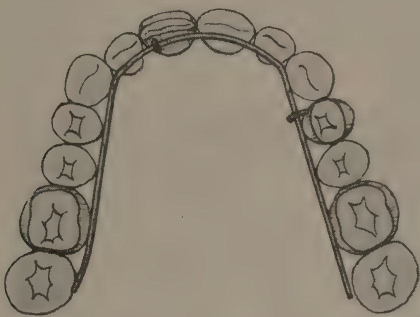


FIG. 994.—Retention of entire permanent arch with fixed lingual arch.

arch, and consists of a small gauged gold and platinum wire (.025″ to .030″) soldered to molar anchor bands cemented into position.

The retention of teeth which have been moved labially or lingually, extruded or intruded, may be accomplished with this method by attaching hooks to the lingual surfaces of individual bands upon the teeth, and bending these hooks above or below the lingual arch, and in such positions

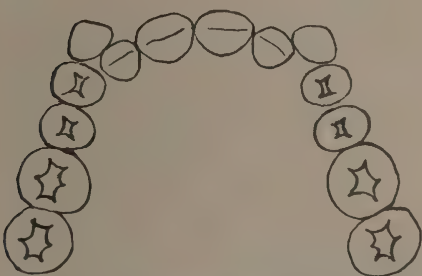


FIG. 995.—Undeveloped dental arch with cuspids in labioversion.

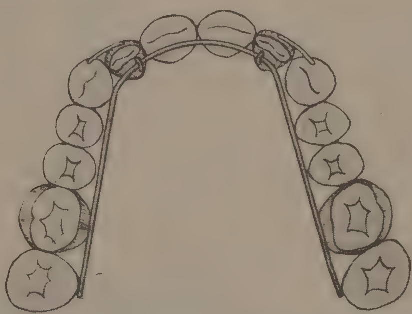


FIG. 996.—Retention of entire permanent arch of Fig. 995 with fixed lingual arch. Cuspids retained by spurs from banded laterals.

as will tend to overcome the particular resistance required. The retention by this method of the right central and left first bicuspid after rotation by individual bands with lingual hooks over the lingual arch is shown in Fig. 994.

It is advisable to construct this retaining appliance and fit it to the teeth temporarily, allowing the teeth to settle somewhat, when the

appliance may be permanently fitted and adjusted. Teeth which have been rotated should be banded, and either retained by labial and lingual spurs upon the bands or by hooks from the bands to the lingual wire to counteract their return tendency. Whereas, in many of the simpler cases of arch development this form of retention is most excellent, yet it is somewhat faulty in construction for those cases in which the cuspids have been in labioversion, similar to the positions shown in Fig. 993 for if the cuspids were banded and supported by the lingual wire they would be held rigidly forward, while the incisors, having some freedom, would

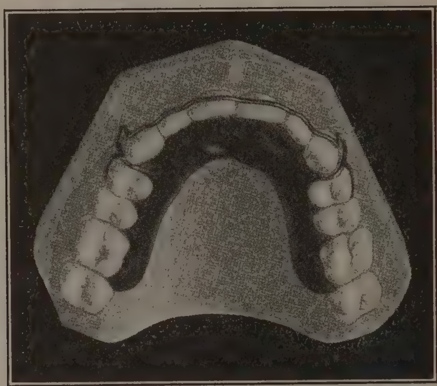


FIG. 997.—The Hawley removable retainer—upper arch.

settle back sufficiently to allow the cuspids to appear still somewhat in labioversion.

In order to obviate this difficulty, the author has constructed a retaining appliance for these cases upon slightly different lines, as shown in Fig. 996. The cuspids are retained by lingual hooks from bands upon the lateral incisors with spurs extending distally over the labial surfaces of the cuspids, effectually retaining them in position and allowing them to settle into their positions even more perfectly. In some of the simpler cases in which the cuspids are not in labial positions, the lingual arch may extend from one first molar band to the other without being attached to incisor or other intervening bands.

Newer Forms of Lingual Arch Retainers.—The newer forms of lingual arch retaining appliances are usually modifications of the locking lingual arch used for treatment of the case. Often the same lingual arch, if of simple design, is left in position for retention with loops anterior to the locking device on the molars and is simple and adequate for the purposes of retention of the mixed or permanent denture.

FIG. 998.—The Hawley removable retainer—lower arch.

FIG. 999.—The Hawley removable retainer with inclined plane to retain the corrected overbite.

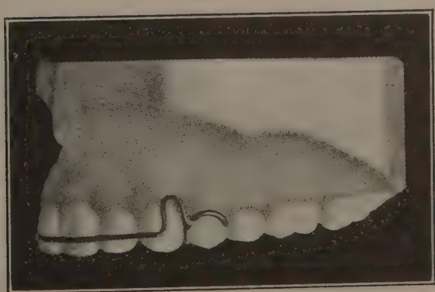


FIG. 1000.—Labial portion and spring clasp of Hawley removable retainer.

The Hawley Removable Retainer.—The interference with the freedom and function of the teeth of any fixed retention has been one of the perplexing problems of the orthodontist, but in the use of the Hawley removable retaining appliance, Fig. 997, for retaining the corrected malocclusion of the permanent arch this interference with the natural movement and function of the teeth is reduced to the minimum. This retainer is a modification and improvement of a retainer described by Dr. R. A. McBride, of Dresden in 1906.

This retainer consists of a skeleton plate of vulcanite accurately fitting the lingual surfaces of the teeth, and supported in position by buccal clasps soldered to short sections of 19 gauge gold wire, which are formed into loops extending labially over the cuspids, one end of each loop ending about the center of the labial surface of the crown of the cuspid on either side, the other end of each loop being extended over the occlusal surface of the arch between the cuspid and bicuspid on each side, and imbedded in the vulcanite plate. Attached to the labial ends of the loops from cuspid to cuspid extends a flat wire .022 inch × .036 inch passing over the labial surfaces of the incisors and being slightly festooned to fit the contour of the labial surfaces of each incisor.

In the lower retainer a wire hook is imbedded in the plate, Fig. 998, and passes between the lingual cusps of the first molar over the margin of the tooth to prevent the plate from being pressed down at the heels.

Besides retaining the width and corrected form of the dental arch, this retainer will retain the positions of rotated incisors by means of the labial wire. Peg shaped lateral incisors or lower bicuspids must be fitted with bands, the former having a flat vertical bar attached to the band and fitting into a slot in the plate, as shown in Fig. 998, while lower bicuspids must be retained by an extension of the bicuspid clasps over these teeth.

The retention of the mesio-distal relations of the arches and of the overbite with this removable retainer of Dr. Hawley's necessitates the building upon the upper plate of a flat or slightly inclined shelf or inclined plane of vulcanite just lingual to the incisors, as shown in Fig. 999. The usual form of clasp for the removable retainer of Dr. Hawley's consists of a short curved wire fitting the neck of the labial surface of the first bicuspid. Fig. 1000, and attached at one end to the labial loop over the cuspid.

An improvement in the clasp of the retainer made by Dr. Hawley consists in its being attached by a separate curved arm nearer the top of the cuspid loop as shown in Fig. 1001.

While there is always the objection to a removable retainer that the patient may not coöperate and continuously wear it, experience has shown that the valuable features of the retainer far out weigh this objection in most cases.

This retainer is also a "working retainer" in that inclination of the incisors may be obtained through its use as well as the movement of individual teeth which have slightly returned to their former positions of malocclusion. The detailed construction of this retainer is illustrated and described in the chapter entitled Constructive Technique.

FIG. 1001.—Improved clasp for Hawley retainer.

A later form of the Hawley retainer, suggested by Dr. Erikson, consists of a narrower vulcanite portion, Fig. 1002, which does not cover the soft tissues. The wire frame work of this narrow retainer is shown in Fig. 1003.

FIG. 1002.—Later form of Hawley retainer.

A narrow retainer very similar to this, but with round wire in front and open tubing at the side into which rubber is vulcanized to fit the teeth, Fig. 1004, has been devised by Dr. McClelland, of Montreal.

Retention of Changes in the Occlusal Plane.—The changes in the occlusal plane necessitating retention are usually those demanded after treatment of infra- and supra-version.

Retention of Infraversion of Incisors and Cuspids.—A continuation of the use of the operative appliances after correction of infraversion of the incisors and cuspids is often the only practical means of affecting their retention. For example, after treatment of this condition with the

FIG. 1003.—Framework of the narrow retainer. It is necessary to continue the wire around the arch in this form of retainer.

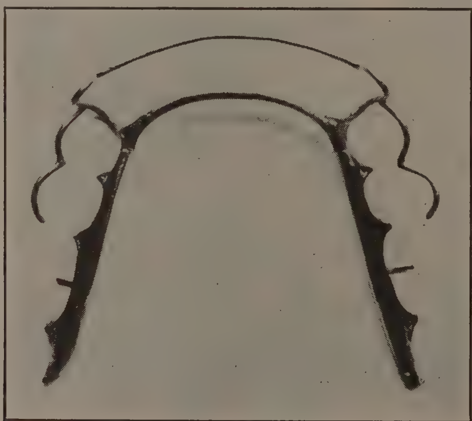


FIG. 1004.—Narrow retainer made by Dr. McCleland of Montreal. This has a round wire in front and open tubing at the sides into which rubber is vulcanized to fit the teeth.

Angle .30 inch sectional arch with upright pins, locked in tubes on incisor and cuspid bands it is difficult to construct a retaining appliance that is more effective than the operative appliance, hence it may be left in position for retention.

After the use of the plain alignment arch for the correction of simple cases of infraversion of the incisors, as in Fig. 824, the alignment arch may be left in position for retention, or a lingual arch of .030 inch substituted, Fig. 996, the incisor bands being provided with lingual hooks which engage with the lingual arch and prevent the return of the infraversion.

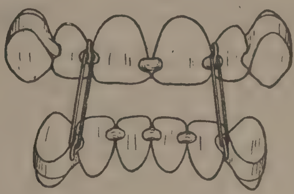


Fig. 1005.—Retention of infraversion. (*C. S. Case.*)

In more pronounced cases of infraversion of the incisors and cuspids in which the alignment arches have been adapted as in Fig. 827, and intermaxillary force used to correct the infraversion, the continued wearing of the alignment arches with the use of very light intermaxillary elastics is essential for the retention.

Dr. C. S. Case illustrates and describes one of the most inconspicuous retaining appliances, after correction of infraversion in his work on Dental Orthopedia. Its adaptation is shown in Fig. 1005.

Fig. 1006.—Retention of infraversion of bicuspids.

In the severe cases of infraversion in which the angle of the mandible has been changed by means of a specially constructed head gear and chin cap, one form of which is shown in Fig. 828, the continuation of the wearing of the head gear and chin cap affords the best means of retention of the case.

Retention of Infraversion of Bicuspids.—The retention of cases after treatment with the light alignment arch for infraversion of the bicuspids as in Fig. 887 consists in the substitution of a lingual arch extending from

one first permanent molar to the other and arranged so that it will pass gingivally to lingual hooks on bicuspid bands and occlusally to hooks on incisor bands as in Fig. 1006. Although it has been claimed by some writers that there is no supraversion of the incisors in connection with infraversion of the bicuspids, the author regards this theory as incorrect from the observations of cases from practice in which the incisors have been intruded in their sockets as much as the bicuspids have been extruded. In this retention, then, there is a reciprocation of the resistance of the bicuspids to become intruded and the resistance of the incisors to become extruded.

Retention of Mesio-distal Changes in Occlusion.—As cases of the **second** and **third** classes of malocclusion present the greatest difficulties in the way of treatment, so also do they require exceptionally difficult retention, for in addition to the necessity of retaining each dental arch in its corrected form and size, including the malposed teeth which have been restored to normal positions, it is almost always essential that the mesio-distal change in occlusion shall be persistently retained for some time after treatment, varying with the age of the patient and the extent of the mesio-distal malocclusion.

Retention of Class II.—In Class II, Div. 1, the average case requires retention of developed arches, of corrected malpositions of the individual teeth, and of corrected mesio-distal changes in occlusion. Also, the corrected changes in the occlusal plane, especially where the abnormal overbite is corrected, require especial means of retention in addition.

Occasionally a case presents in which the restoration of function of the occlusal inclined planes needs no other retention than the normal action and reaction of these inclined cusp planes upon each other in occlusion and articulation. A case of this kind belonging to the second division of Class II is described under treatment of this class and illustrated in Figs. 906 and 907.

As illustrative of the fact that mesio-distal retention upon the molars in early treated cases is not always necessary after treatment in the divisions of Class II, cases have been reported in which the retention consisted simply of an inclined plane of gold attached to the upper central incisors as illustrated in Fig. 884, tending by its action at each closure of the mouth to cause normal locking of occlusal planes.

Antagonizing Spurs.—The simplest retention of the normal mesio-distal relations of the dental arches, after shifting the occlusion, is by means of spurs soldered to the buccal surfaces of upper and lower molar anchor bands, these spurs being so related that they act as inclined planes continually forcing the occluding molars into their proper cusp relationship during each closure of the jaws, or *auxiliary occlusal retention.*

Fig. 1007 illustrates the positions of the buccal spurs for the retention of the mesio-distal relations established after treatment of a case of Class II.

The buccal spurs upon the molar bands are preferably constructed of square wire, of platinized gold or iridio-platinum, affording flat surfaces for the antagonizing of the two spurs in occlusion. These spurs are adjusted after a method suggested by Dr. Watson, being a modification of the spur and plane method described by Dr. Angle.

Fig. 1007.—Retention of corrected distoclusion by antagonizing spurs.

Occasionally it will be found that the buccal spur on the upper molar band in Class II may be dispensed with, allowing the lower buccal spur to antagonize the plane of the mesial angle of the mesio-buccal cusp of the upper first molar, especially in cases in which the permanent bicuspids are unerupted.

The buccal spurs are also effectual in retaining single molar or bicuspid teeth which have been moved buccally or lingually into proper occlusion, as described by Dr. Angle.

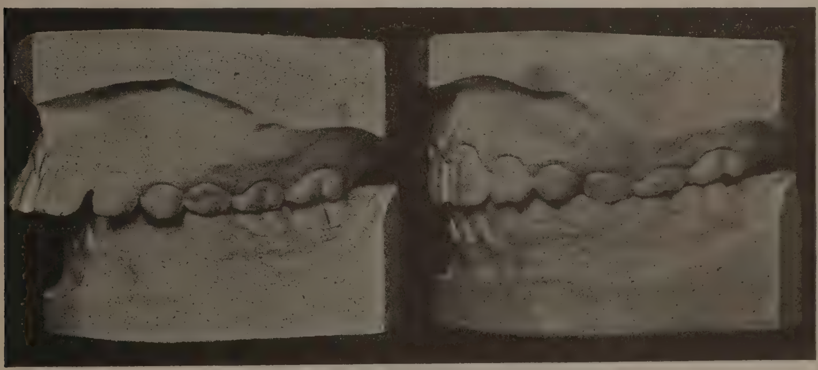


Fig. 1008.—Distoclusion case before and after correction.

Fig. 1008 illustrates the left occlusion of a case of Class II, Div. 1, before and after treatment. It is useless in cases in which the upper incisors are protruded to the extent shown in this case to expect that restoration of function of the inclined planes of the incisors will be sufficient to retain the normal relations of occlusion which have been established in the incisor region, and it is advisable to retain the mesio-distal change in occlusion until the eruption of the permanent bicuspids in a case undertaken as early as this one.

A buccal and occlusal view of the retaining appliances used in this case is shown in Figs. 1009 and 1010, the antagonizing spurs upon upper and lower molar bands serving to retain the normal mesio-distal relationship established between the arches.

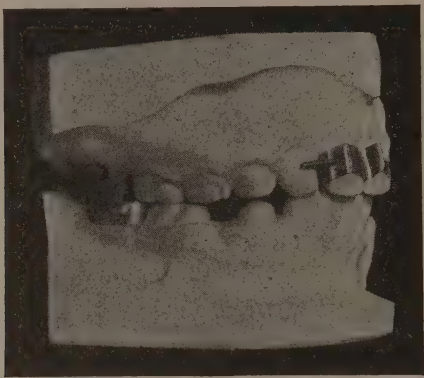


FIG. 1009.—Spur and plane retention of corrected distoclusion shown in Fig. 1008.

The lingual arch, acting in conjunction with cemented incisor bands, attached with lingual hooks, effectually retains the upper arch in its normal form and the upper incisors in their normal positions.

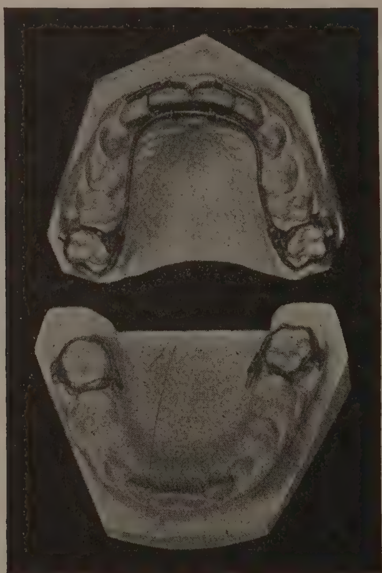


FIG. 1010.—Occlusal view of corrected distoclusion shown in Fig. 1008 exhibiting lingual arch retention of upper arch.

Intermaxillary Retention in Class II.—(Normal Overbite.) A method involving the use of intermaxillary retention of Class II, Div. 1,

illustrated and described by Dr. Watson in 1908, is still in use with a few modifications such as the substitution of plain bands for clamp bands. The upper appliance A, Fig. 1011, engaging with the lower appliance by means of intermaxillary elastics, consists of a threadless buccal arch, of 18

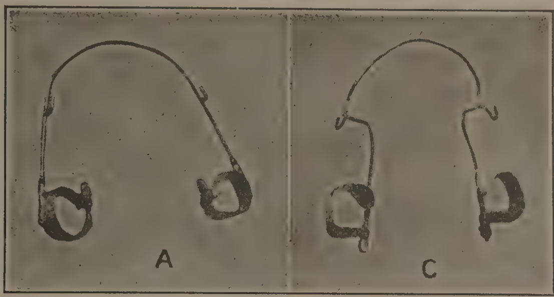


FIG. 1011.—Retention of upper arch of distoclusion case with labial and labiolingual arches (*Watson.*)

to 20 gauge iridoplatinum (20 per cent iridium) sliding into close-fitting buccal tubes on first molar bands, a little collar soldered to either side of the arch just in front of the buccal tubes, causing the pressure to be equally distributed. The intermaxillary elastics are adjusted with the lower

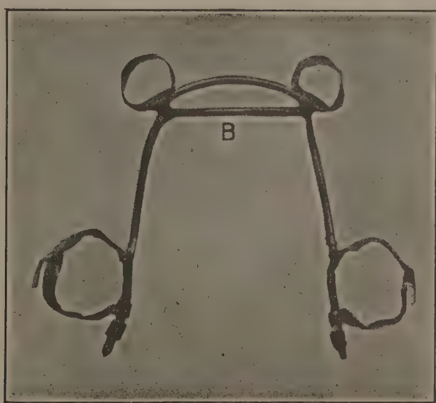


FIG. 1012.—Retention of lower arch of distoclusion case. (*Watson.*)

appliance so as to preserve a proper balance only of the forces tending to cause a return of the distal occlusion, a very delicate elastic being finally used for the purpose. The retention of individual teeth is independent of this appliance.

A modification of the appliance on the upper dental arch described by Dr. Watson, consists of an arch wire, C, Fig. 1012, so formed as to rest

on the labial surfaces of the incisors, and passing between the cuspid and first bicuspid on each side, extends and is attached to the mesio-lingual angle of the molar band. Hooks for intermaxillary elastics are attached at the angle formed by the arch wire bending lingually in the cuspid region. This form of arch wire serves to retain arch development in the bicuspid region, as well as the form of the anterior portion of the arch.

The retention of the lower arch was also affected by means of a lingual appliance made in two separate portions, as illustrated in Fig. 1012. The six lower anterior teeth are retained by banding the cuspids and uniting these bands with a lingual wire resting above the lingual ridge. A lingual arch B is then bent to fit against the lingual surfaces of the bicuspids, resting against the cuspid bands and fitting closely under the ends of the wire attached to the cuspid bands and crossing the lingual surfaces of the incisors in close proximity to the gums. The distal ends of this lingual arch are attached to the mesio-lingual angles of the molar

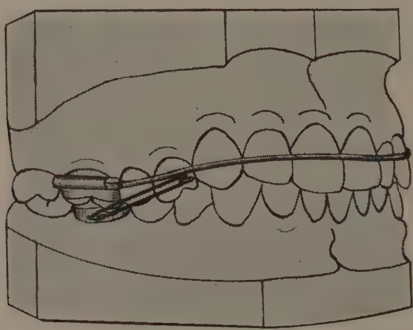


FIG. 1013.—Intermaxillary retention of Class II, Div. 1 with labial arch and lingual arch on lower.

bands, and the hooks for intermaxillary elastics are soldered to the buccal surface of these bands. The object of the appliance being thus made in two separate pieces is twofold:

1. The six anterior teeth, especially the cuspids, are more perfectly retained with a lingual wire from one cuspid band to the other than by a lingual arch attached to molar bands and resting against these six anterior teeth.

2. The teeth thus retained in sections have an opportunity to become self-supporting more rapidly than when all the teeth in one arch are bound together, as it were, by a lingual wire attached firmly to cuspid and molar bands.

In the wearing of these appliances for retention of cases of Class II, Div. 1, the intermaxillary elastics may be worn at night, and discarded after a time, leaving the buccal and lingual arches in position to retain

the form and development of the dental arches for a still longer period.

In the simpler cases of mixed dentures of Class II, Div. 1, in which there has been no appreciable change in the underbite, a mesio-distal retention only being necessary in addition to the retention of developed upper and lower arches and corrected individual tooth malpositions, the upper alignment arch which was used for treatment, as illustrated in Fig. 1013, may be worn day and night during the first part of the retaining period, with intermaxillary elastics of decreasing strength; then in the second part of the retaining period the upper alignment arch is worn with the most delicate elastics at night only, then alternate nights, and finally discarded. The alignment arch in these cases must closely fit the buccal tubes and be provided with friction nuts. The form and size of the upper dental arch may be retained with a fixed lingual arch soldered to the molar bands, or by a removable lingual arch closely fitting the lingual surfaces of the teeth as shown at the left of Fig. 1014.

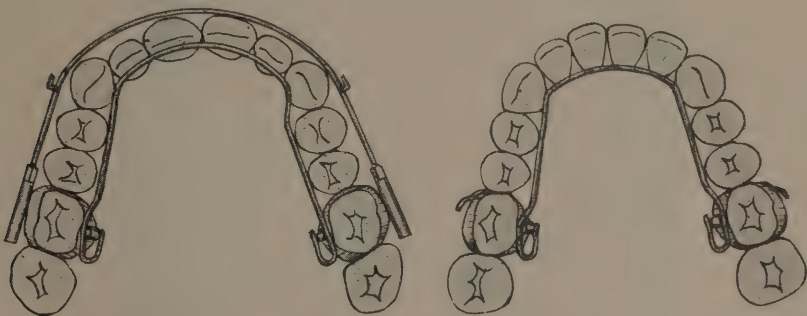


FIG. 1014.—Intermaxillary retention in Class II, Div. 1 with removable lingual arches to retain arch form, and upper labial arch for attachment of intermaxillary elastics.

The lower dental arch, when of regular form, needs but little retention for lateral development beyond that afforded by a simple removable lingual arch attached to molar bands, having intermaxillary hooks soldered to their buccal surfaces as illustrated at the right of Fig. 1014.

The use of many soldered bands is always an objectionable feature of retention, because they give so little opportunity for the teeth to become self-supporting, and also because of the difficulties attending the re-cementation of the bands when one or more become loosened. When necessary to attach the lingual arch to incisor and cuspid bands, it is advisable to use lingual hooks bent over the arch wire as suggested by Dr. Lourie.

Retention of Class II, Div. 1, Subdivision.—The intermaxillary retention of the subdivision of Class II, Div. 1, in which the occlusion is normal on one lateral half and distal on the other, varies but little from the retention of the corrected bilateral distal occlusion, since it is necessary

to wear a very light intermaxillary elastic on the normally related side in order to more perfectly balance the force of the stronger elastic needed on the side formerly in distal occlusion.

Intermaxillary Retention in Class II after Change of Occlusal Plane. (Abnormal Overbite.) In some of the cases of mixed dentures of Class II, Div. 1, in which the occlusal plane has been changed, the operative appliances are used for retention, the alignment arch being continued on the upper in connection with the use of the bite plate, the lower arch being retained with a lingual arch wire. In these cases it is necessary to retain both a mesio-distal change in the dental arches as well as a change in the occlusal plane. Hence, the intermaxillary elastics should be adapted as in the treatment to exert a vertical as well as a horizontal pull effected by the

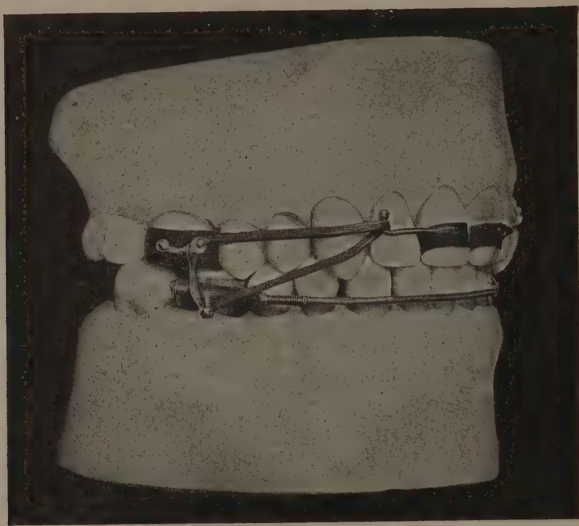


FIG. 1015.—Retention of corrected occlusal plane by fixed inclined plane operative appliances in position. (*A. P. Rogers.*)

triangular arrangement in Fig. 1015. The elastics used should be decreased in strength during retention so that only the most delicate intermaxillary force is needed to balance the antagonizing resistance. This retention should be worn day and night during part of the period of retention, and nights only for another period, and finally discarded after the eruption of the bicuspids to occlusion if the length of time of retention and the developmental changes will warrant it.

In some cases it is advisable to use the fixed inclined plane for retention of these cases one form of which is shown in Fig. 1015, a combination suggested by Dr. Rogers in which the triangular arrangement of the intermaxillary elastics is used with the inclined plane for both treatment and

retention. A lower lingual arch is substituted for the alignment arch during retention.

Fig. 1016 illustrates an inclined plane of looped wire in connection with a removable lingual arch. The use of the wire loops, suggested by Dr. J. Lowe Young, makes a much lighter inclined plane than can be constructed any other way and the open spaces make it more easily cleaned. The distal tendency of the lower arch is counteracted by the inclined plane all

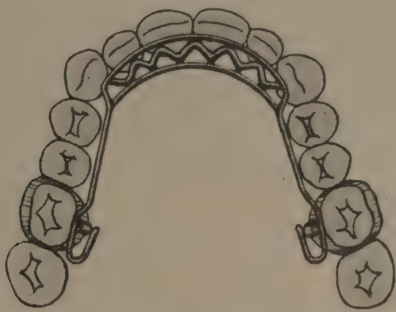


FIG. 1016.—Loop inclined plane for retention of corrected overbite and mesio-distal relations of occlusion.

of the time whether the intermaxillary elastics are worn or not, and in many cases this combination is advisable.

Retention of Corrected Infraversion of Bicuspids and Molars in Class II, Div. 1.—The occlusal planes of both upper and lower dental arches in some of the more mature cases require such extreme changes that the tendencies to return to these abnormal planes requires retention by a continuation of the use of the operating buccal alignment arches as in Fig. 870. Occasionally it is necessary, either after correction of the infraversion of the lower bicuspids and molars or of a supraversion of the lower incisors, to adopt this same form of retention of the lower dental arch.

Retention of Class II, Div. 2.—The retention of Class II, Div. 2, differs from that of the first division of Class II in very few respects. The upper dental arch, however, presenting with a torsal or lingual tendency of the upper incisors, requires usually the use of the lingual retaining arch, with bands and spurs on the individual incisors to resist the tendency to rotate or return to positions of lingual inclination. These cases usually possess a deep overbite, indicating infraversion of the bicuspids and molars, and occasionally supraversion of the incisors, and the retention of corrected occlusal planes in this division is the same as in that of the first division of Class II. The use of the spur and plane is well adapted for retention of the mesio-distal change in this division of Class II. Occa-

sionally, however, the continued use of intermaxillary force may be indicated.

Retention of Class III.—The retention of a corrected mesio-distal change in Class III is usually much simpler than in Class II. In early treated cases, where a sufficient overbite is obtained after treatment,

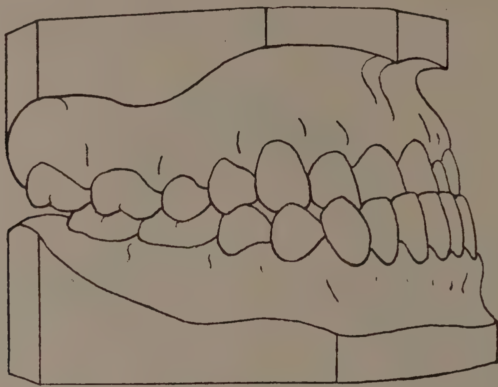


FIG. 1017.—Adult case of Class III requiring intermaxillary retention.

considerable dependence may be placed upon the *occlusal retention* of the incisors in normal occlusion. In early treated cases in which it is impossible to obtain much of an overbite of the incisors, an upper lingual arch holding the upper incisors forward, attached to molar bands, with buccal

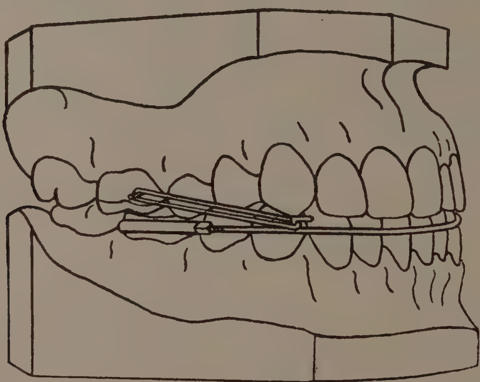


FIG. 1018.—Intermaxillary retention of adult case of Class III, with a lingual arch retaining the form and size of the upper dental arch.

spur and a lower buccal plane reversed from the relations, shown in Fig. 1008 for Class II retention is advisable.

In more mature cases of greater severity, as in Fig. 1017, intermaxillary retention adjusted as in Fig. 1018 from a lower alignment arch to hooks on upper molar bands attached to a lingual arch seems necessary.

The chief consideration beyond that of the correction of mouth-breathing habits is the establishment of an overbite. In some cases it is necessary to discontinue treatment if an "open bite" condition is liable to ensue on continued treatment with intermaxillary force, hence, in the use of this force for retention the occlusal relations of the upper and lower incisors must be carefully guarded.

Duration of Retention Period.—Usually the retention of a corrected malocclusion is a matter of more than a few weeks in point of time, many cases requiring months, and some of the more severe cases, several years of retention in order to overcome the resistance, and the tendency of the dental arches to contract or assume their original forms and relationships after having been restored to a normal condition of occlusion, or after being mechanically developed up to a physiological limit.

The retention of the deciduous teeth is a process of temporary maintenance of the development of the arches alone, while the retention of the permanent teeth is often a necessity for their maintenance in their relative positions in the arch, although developmental changes are still going on.

The length of time of retention of the arches of deciduous teeth, at the most, can only last until the eruption of the permanent teeth, in whole or in part.

In the dental malocclusions of the child from six to ten years of age, the rapid restoration of function through orthodontic treatment is so aided by the stimulation to normal growth that the retention of these cases is a matter of a few weeks or months only, except in cases of distal occlusion and its accompanying lack of vertical development of the dental arches, or in cases of infraversion in other regions.

Developed arches of these early undertaken cases need to be retained only until the eruption of permanent incisors, cuspids or bicuspids, according to the age treatment is begun. Incisors which have been rotated during or soon after eruption need but a few weeks' retention before the rapidly developing alveolar process and the fibers of the peridental membrane accommodate themselves to new conditions of resisting tendencies to displace these teeth from their new positions in normal occlusion. In the more mature cases, the resistive qualities of the osseous structures in which the teeth are implanted, and of the fibrous elastic membranes with which they are surrounded, are in evidence until long after treatment is completed, and unless these reactive forces are inhibited for varying periods after the completion of treatment, more or less of a return of former conditions of imperfection of form, and of occlusal relations of the dental arches is inevitable.

Permanent teeth, which have been moved into their normal lines of occlusion during eruption, or immediately after, need retention for a far

shorter time than if they have been confirmed in their abnormal positions for some time before being corrected.

Added to these untoward influences the possible abnormal habits of mouth breathing, thumb- and lip-sucking, and the abnormal tension of the muscles of the tongue, lips and cheeks, and the abnormal influence of inclined cusp planes present in many cases, the forces which tend to resist normal development and function may be considerable, and the retaining period may be indefinitely prolonged.

CHAPTER LXIII

KINESIOLOGY IN ORTHODONTIA

Relation of Kinesiology to Orthodontic Treatment.—The modern orthodontist, in his investigations into the etiology and therapy of abnormal relations of the muscles of the jaws, has closely studied the normal and abnormal tendency of the various muscles of the jaws and face with the object of restoring normal action of these muscles and thereby normal pressures upon the teeth and jaws, and restoring lines of beauty to the features through a balanced and co-ordinated musculature. This is properly included under the study of *kinesiology*, or the therapeutic movements of muscles.

Orthodontists have been content in many cases to restore the relations of normal occlusion and pay but little heed to the forces of occlusion and retention, which, as Dr. Dewey points out, are the same, preserving the relationship of normal occlusion and the integrity of the dental arches, viz., the inclined planes of the cusps, harmony in the size of the arches, normal proximate contact, normal atmospheric pressure, normal cell metabolism, and normal muscular pressure.

The last of these forces in particular, *normal muscular pressure*, has been until recently very much neglected, especially when one considers the wonderful possibilities in training the weakened and abnormal musculature found in malocclusion up to a normal standard in favorable cases.

However unconsciously negligent the orthodontist may have been in the past in this respect, in the scientific restoration of normal muscular action and harmonious co-ordination of the muscles of the jaws and face, he has been stimulated to enthusiasm and effort along the line of *kinesitherapy* through the scientific methods used and successful results accomplished in muscle training by Dr. Alfred P. Rogers, from whose articles on the subject the author freely quotes or interprets in a condensed summary in the following paragraphs.

Realizing that in malocclusion of the teeth, especially in the mouth-breathing cases of neutro- and disto-clusion, the muscles of the jaws and face are susceptible to many disharmonizing influences, this author has applied stimulating and corrective treatment in these cases for the express purpose of restoring harmony in action and balance to these muscles, educating the patient in a *conscious control* of whatever group of muscles is weakened through disuse, or acting abnormally from any cause.

This muscle training consists of certain exercises for the development of these muscles during, and, if necessary, after treatment of malocclusion in the period of retention. Many of the simpler, and some of the more complex cases of malocclusion have been corrected without appliances by the conscious control of the special groups of muscles involved, through persistent and systematic exercises prescribed for the needs of the individual case.

Necessity for Muscle Training.—The action of abnormally acting muscles, having become habitual, seldom attain normal action even with all interferences of malocclusion, respiratory obstruction, etc., removed, hence the necessity for the training of these musc es along normal lines of action through conscious intelligent control by the patient under the instruction and guidance of the orthodontist assisted by the parents, whose coöperation must be complete. As illustrative of the habitual abnormal action of certain groups of muscles of the jaws and face, especially the ptygeroids, the abnormal action of these muscles in the mouth-breather becomes a habit through necessity, but even after the removal of adenoids or other obstruction to normal respiration through the nose, the disfiguring appearance of the open, drooping mouth, due to the acquired abnormal muscular habits, does not readily disappear, and in many cases requires the most persistent treatment through scientific muscle training in order to obtain satisfactory results.

"Vicious habits which endanger the permanence of results are assuredly on the increase. Every orthodontist of experience has among his patients almost every type of child, but the most trying are those who have assumed habits which combat his skill."*

Psychotherapy of Muscle Training.—"In helping our patients to help themselves we have a psychological problem. It is none other than the teaching of our patients to break old and disastrous muscular habits and substitute in their places normal muscular action. In teaching *conscious control* of any muscle or group of muscles it will be understood that *the will of the child must be so strengthened that it is able to withstand the insiduous demand for wrong actions. The seat of the trouble is in the mind, and to the mind the operator must direct his attention.*"

"It will frequently be found extremely difficult to assign any reason for many of the actions which will come under his notice. In fact, the majority of these habits are exasperatingly unreasonable, and therein lies a potent cause for anxiety. The actions are almost invariably found to be unconsciously performed. Some actions are slow, others are so quick as to almost deceive the eye. Some are performed during the

* Teaching our Patients to Overcome Undesirable Muscular Habits, By Dr. Alfred Paul Rogers, Proc. Amer. Soc. of Orthodontists, 1919.

waking hours, some during the hours of sleep. Studious children, of a not too robust constitution, are frequently found to be the victims of these self deforming habits. In a word, they seem to be an accompanying compensating evil which nature exacts of us more and more as civilization advances."

Influence of Suggestion in Habit Cases.—"It is usually good practice when undertaking the correction of any habit to request the parents to make no reference to the habit in the hearing of the child; to leave the entire treatment in the hands of the operator. It is then essential that the child's attention be called to its abnormal performance in such a manner that it is brought to understand the nature of the habit and its consequences. Next, *there must be created within the mind of the child the conscious desire to rid itself of whatever action is proving disastrous.*" . . . "The efforts cannot be intermittent, but must constitute as regular and as active a part of the treatment as the application and adjustment of appliances. They must also be accompanied by whatever methods the operator finds necessary for the building up of the health and strength of all muscular tissues surrounding the muscles involved, because teaching the conscious control of other groups of muscles will tend to develop a stronger will power in relation to muscle work, one that will be instrumental in destroying the abnormal impulse."

Normal Environment Advisable.—"In undertaking the treatment of these victims of habits, one of the first duties of the orthodontist is to endeavor to establish a more healthy and a more normal environment for his patients. Prescribe more outdoor life, more natural modes of living, greater care in selection of foods, less anxiety on the part of the parents for the extra scholastic standing by these children which is so often obtained at the cost of serious sacrifice of health through the excessive demand on their nervous energy."

In carrying out Dr. Rogers' ideas of muscle training in respect to the minor muscular defects about the mouth and jaws, it must be assumed that every abnormal action of any muscle or group of muscles is a habit of greater or lesser degree, and in extent or severity related to the length of time it has been operative, and to the malocclusion associated with it. The principles of muscle training are, therefore, applicable as well in cases of minor muscular actions which are abnormal as in those cases which are more extreme involving muscular habits which are more insiduous and persistent.

Principles of Muscle Training.—These principles are:* "*First, the mechanical re-establishment of arch form and cusp relation by the simplest*

* Muscle Training and its Relation to Orthodontia, By Dr. Alfred Paul Rogers, Proc. Amer. Soc. Orthodontists, 1918.

mechanical means, thus removing any interference which tends to discourage the norma functions of the musc es.

"*Second, the principle of muscular balance and mechanical advantage in the complete organism, including special guidance and control of those muscles concerned in the particular weakness upon which our attention is to be directed, urging them on to their normal development and strength until the harmoniously developed face completes the restoration of the organism to its normal inheritance.*"

Relative to the first principle Dr. Rogers says, "It is unfortunately true that in many growing cases it is absolutely essential to our ultimate success that we make use of certain forms of mechanical apparatus; but it is essential to so design them that they will interfere as little as possible with normal muscular activity. Textbooks on orthodontia frequently show illustrations of appliances filling the buccal and lingual spaces. The use of these appliances would not be compatable with the simultaneous encouragement of functional activity of the soft tissue. It would be difficult under such circumstances to train the muscles with a free and unhampered action. In most cases the use of the lingual arch wire is more nearly in accord with the principles under consideration. In younger cases, where the deciduous teeth are still present, the junior pin and tube appliance is sometimes made use of during the early stages of treatment, being removed after a sufficient development has been obtained to allow of a free eruption of the teeth,—the lingual wire being used on the lower to secure the arch development while the muscles of mastication and expression are being trained to their normal activity."

Application of the Second Principle of Muscle Training.—Relative to the second principle of muscle training, that of muscular balance and mechanical advantage of the complete organism, including special guidance and control of those muscles concerned in the particular weakness upon which the attention is to be directed, Dr. Rogers further states: "This muscular work must go along with the mechanical treatment of the case, and no undue muscular pressure must be allowed until *the patient has learned to place the arches in their proper relation*, which function is taught to them after the major interferences have been removed. The object of the work is to so strengthen the muscles of mastication that they will assume their normal function, not only resulting in a maintainence of occlusion, but in building a stronger masticatory apparatus as well, *that the so-called muscles of expression shall be so trained as to be under conscious control*, and not allowed to 'run riot in response to almost every emotion.'"

Muscle Training in Distoclusion Cases.—"In the early stages of treatment in these cases the patient may be trained to overcome the

handicap by applying proper mental stimuli; and when the time appears when proper adjustment of the mandible with the rest of the skull is possible, the adjustment takes place quite normally, and then, if it is supplemented by the strengthening of the temporal and masseter muscles, results are permanent and more beautiful because of the harmonious development and action."

"In contemplating work of this nature, the orthodontist must ever bear in mind the fact that *muscles tend to stay in the position that they do the most and hardest work, and this work must be done with the arches in their true relation to one another*, for it is then that the masticatory apparatus has assumed the position of mechanical advantage, and it will be sur-

FIG. 1019.—Exercise for internal and external pterygoids. Throwing mandible forward and relaxing it. (*After Rogers.*)

prising how quickly the various muscle groups will respond to the work thus placed upon them, because they are in the position which Nature has intended that they should occupy."

Training the External and Internal Pterygoids.—"It would be logical for us at this point to direct our attention to that most important group of muscles—the external and internal pterygoids. The advantageous positions which Nature has given these groups will be readily seen. They are the muscles which control the movements of the mandible. During early life they are readily controlled, which accounts largely for the fact that they often give way to suggestions furnished them by slight interference

incident upon the narrowing of the upper arch and by the interference of the upper lateral incisors in lingual occlusion. If the mandible is forced into distal position, these muscles soon form a habit of keeping it there. It may be well for me at this point to emphasize the importance of the early exercise of these muscles in cases where it is required. This is true even where intermaxillary elastics are proposed, or where inclined planes upon the anterior teeth are contemplated."

FIG. 1020.—Combination of exercise for pterygoids and general posture exercise. (*After Rogers.*)

"The exercise of these muscles consists in throwing the mandible forward, as shown in Fig. 1019. The patient requiring this form of exercise is instructed to throw the mandible forward as far as possible, or until the lower anterior teeth are placed in labial occlusion to the uppers, and held there ten or more seconds and then slightly relaxed. The effort is then repeated as many times as the nature of these cases requires. In

some cases this will at first be found impossible, but after practice the work becomes easy. This form of exercise is usually prescribed in cases of distal occlusion, and the operator must here be careful in his diagnosis.

A very little of this exercise is sufficient in some, while in others it is almost impossible to overdo it. Still further efforts are made for some patients, as shown in Fig. 1020, which shows a combination of a posture exercise of unusual merit, and the pterygoid exercise. The patient is

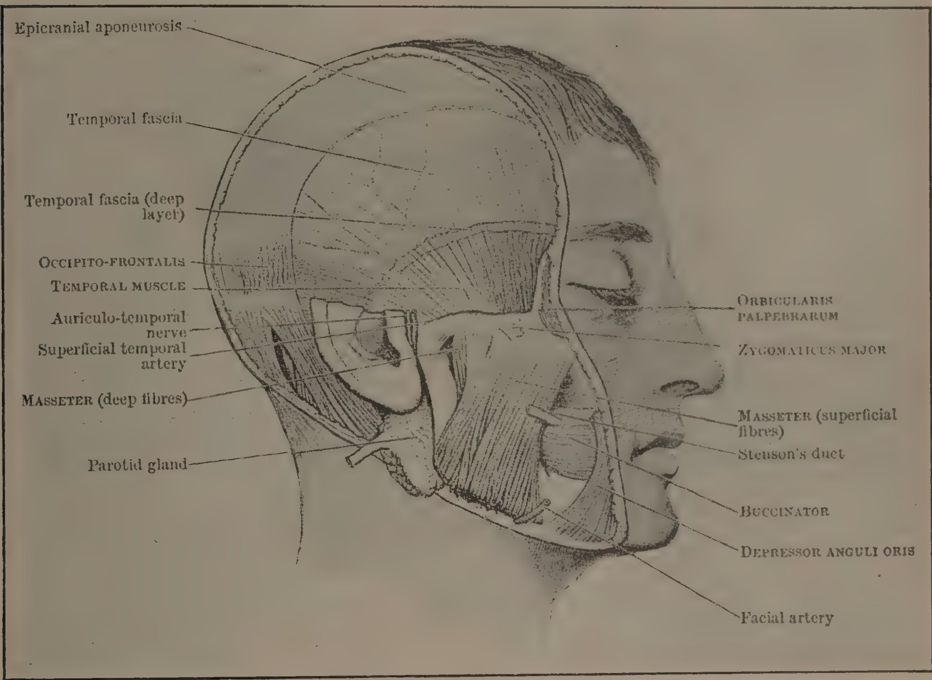


FIG. 1021.—Positions and relations of temporal and masseter muscles. (*After Rogers.*)

directed, after taking the position here illustrated, to stretch the point of the chin upward as far as possible, bringing vigorous strain upon the platsyma myoides.

Exercise for the Temporal and Masseter Muscles.—After the ability to place the teeth in proper relation has been acquired, the patient has another exercise added—that of the temporal and masseter muscles. Fig. 1021 illustrates the positions and relations of the temporal and masseter muscles. This exercise consists of holding the teeth firmly in occlusion and alternately contracting and relaxing this group of muscles. In many cases it will be found that the ability to contract these muscles is very slight indeed, and after a few months of practice, the operator is gratified to find greatly increased tone and improved control, as is shown

by the ability to contract and relax. All efforts must be made with great concentration and must be complete in their relaxation and their contraction. The ability to completely relax these muscles between each impulse is important to secure, as muscles exerted in this manner, for physiological reasons, grow stronger much more quickly.

Figure 1022 shows a child in the act of stimulating these groups. The position of the fingers is useful, in the beginning, in teaching the child to detect the movements.

FIG. 1022.—Exercise for temporal and masseter muscles. (*After Rogers.*)

FIG. 1023.—Exercise for temporal and masseter muscles. Pitting these muscles against those of the hand and arm. (*After Rogers.*)

Figure 1023 shows a form of exercise for these muscles which may be given when it is not wise to place the teeth in occlusion, and is used sometimes in anticipation of the exercise just described. It is performed by directing the child to pit the muscles of mastication against those of the hand and arm, alternately and relaxing.

Tongue Exercise.—As an accompaniment to the masseter-temporal exercise the tongue exercise is one which has particular virtue, as it is also trains the tongue and strengthens those muscles which are particularly influential in the development of the lower arch. After the child has learned the masseter-temporal exercise he is then instructed to place the tip of the tongue against the mucous membrane directly behind the lower incisor teeth, and with each contraction of the masseter-temporal group of muscles, press the tongue against the anterior section, and, at the same time by the act of widening the tongue, force it against the lateral sides of the alveolar process. This exercise trains the tongue to remain in its proper position and has a tendency to prevent the narrowing of the lower arch, facilitating the early removal of retentive appliances.

Necessity for Training the Orbicularis Oris.—Many have had difficulty in retaining the upper incisors in correct position. It is necessary, frequently, to apply retaining apparatus to effect this purpose, but if in the meantime, this muscle has not been strengthened in case it originally lacked tone, upon the removal of the retaining apparatus the incisors again become protruded. One particularly obstinate case yielded to treatment applied for the strengthening of the orbicularis oris muscle.

Exercise for Orbicularis Oris.—"Accompanying the previous exercises a special exercise for the orbicularis oris is found of value. For this purpose I have constructed a small instrument which the patient uses at home which is shown in Fig. 1024. The smooth dental ends are inserted between

FIG. 1024.—Mechanical exercises for orbicularis oris. (*After Rogers.*)

the lips which the patient is directed to contract, stretching as far as possible the elastics which engage the opposite levers. Elastics may be added as the strength of the muscle increases."

"This instrument is so designed that it is difficult to keep it within the aperture unless the muscle is properly contracted. During its operation the patient should not allow the instrument to stretch his lips. It must not be overlooked that the orbicularis oris muscle is composed mainly of two sets of fibers, not considering the fibers of the muscles which intersect. Therefore, in making the efforts with the exerciser this should be kept in mind and these fibers held in as nearly normal relation as possible. For instance, if the patient is allowed to pout or curl the lips during the exercise the effect upon the orbicularis oris muscle is not as favorable, but if the fibers are kept in the position which they assume when pronouncing the word "prism" the exercise is greatly facilitated and a more rapid development is obtained. The exercise is continued with one elastic during the first week or so and contractions are increased each day until they reach fifty

or sixty. When the muscle grows in strength an increase in the number of bands may be made. It is rarely necessary to employ more than two elastics. Teach the child to control the extent of action of the rubber bands. It is not wise to overload the muscle, because, as you know, any muscle trying to lift a weight beyond its ability is apt to sustain injury. The weight which the muscle should lift must be well within its capacity, increased contractions making up for the lighter task."

FIG. 1025.—A variety of mouths benefited by exercise for the orbicularis oris muscle. (*After Rogers.*)

Figure 1025 represents a variety of mouths which have received benefit from this method of treatment.

Tonic Exercise for General Facial Development.—"It is frequently found necessary to prescribe a tonic exercise, which I have termed the exercise for general facial development. This exercise influences not only the orbicularis oris, but also the buccinator and all the small ribbon muscles which enter into a combination with the orbicularis oris. It consists in the use of warm water at a temperature which is bearable to the mucous membrane of the mouth, and in which has been dissolved a small portion of bicarbonate of soda. The patient is directed to take a sip of this solution closing the teeth firmly in position, and with great energy forcing the liquid from the lingual cavity into the buccal. The exercise is usually done five times, morning and night. The patient is directed to continue each exercise until the muscles are slightly fatigued. A not unpleasant aching sensation is the indicator of the successful effort. The heated liquid adds a distinct advantage to this exercise, as it has a tendency to dilate the blood vessels, thus producing a more copious supply of nutritive material. At the termination of this exercise, the face will be found to glow with warmth."

General Posture Exercise for the Platysma Myoides.—"The platysma myoides is a muscle which, to my mind, is of great importance when considering the correction of faults in the facial muscular development. This muscle has no bony attachments, but is inserted in the facia and skin of the pectoral and deltoid muscles of the chest and upper shoulder at one end, and at its facial extremity is inserted by many fibers into the orbicularis oris and some of the other muscles upon or near their entrance into

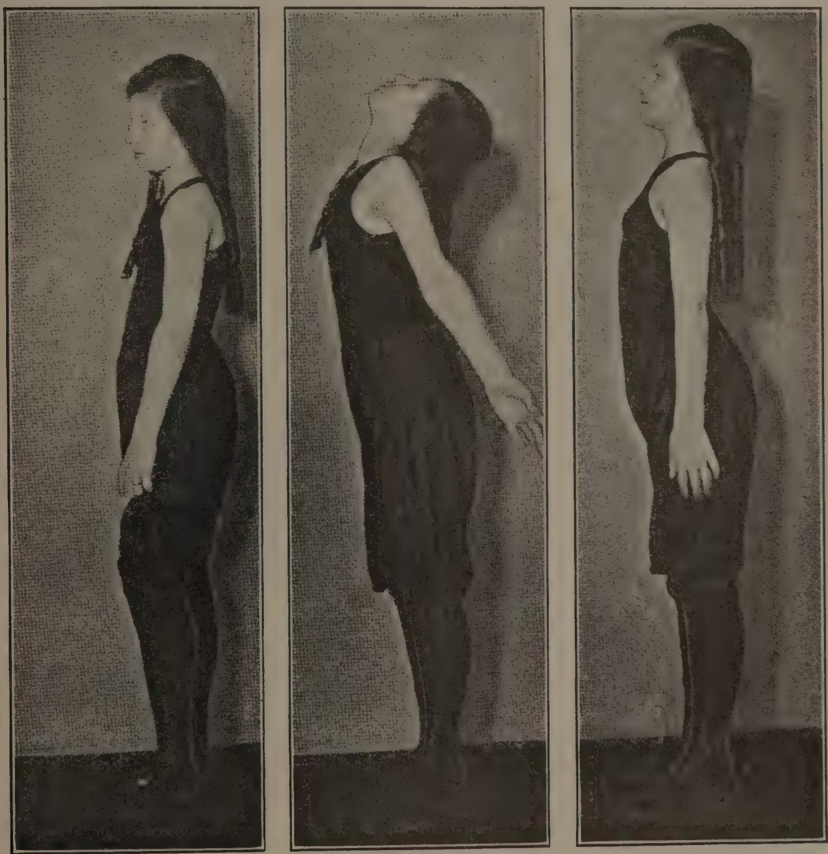


FIG. 1026.—General exercise for platysma myoides. (*After Rogers.*)

the same. It will then be seen that if this muscle is contracted in its length by the bad posture of the patient, it has a tendency to stretch the weakened muscles of the face in the directions which bring gentle but harmful pressure upon the fragile bony structure of the child's face. The exercise for this muscle is found in the general posture exercise illustrated in Fig. 1026, which consists in having the patient stand with feet together, hips slightly thrown back, directing the child to look straight forward to

the zenith, at the same time drawing in the abdominal wall and turning the palms of the hands upward, making a slow and positive stretching motion with the tips of the fingers and the point of the chin. The child is then directed to relax somewhat, bringing the head and arms to a direct position —then repeating the impulse. This exercise is done at first a few times in

FIG. 1027.—A case from Dr. Roger's practice exhibiting maladjustment of muscles of face and chest.

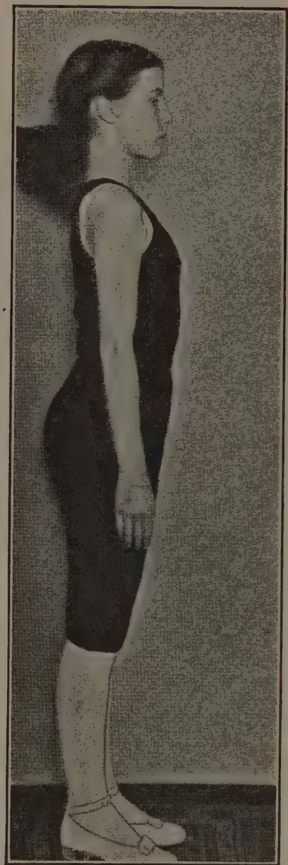


FIG. 1028.—Same case as shown in Fig 1027 after treatment by exercise for general posture. (*After Rogers.*)

the morning upon arising, and a few times before retiring, the number being increased until the child is able to do it sixty to one hundred times a day. It is important in this exercise that the child be not allowed to curve the vertebrae so that the back represents much of a concavity. To avoid this the child is directed, when drawing the abdominal wall, to tighten at the same time, the muscles of the buttocks. A slight forward movement of the body, bending slightly at the ankles, thus bringing the

weight of the body slightly upon the balls of the feet, enhances the position of mechanical advantage in this exercise."

Fig. 1027 illustrates a case from Dr. Rogers' practice in which not only were the muscles of the maladjusted, but there was no evidence of mechanical muscular balance. Fig. 1028 exhibits the same child "after two months treatment in following the instructions given her respecting conscious guidance over muscular activity together with orthodontic treatment for the correction of the maldevelopment of the bones of the face and malocclusion of the teeth." The exercise which this child was taught to undergo consisted in gaining control of the pterygoid muscles and control of the muscles of the trunk, particularly those of the abdomen. The marked improvement in her physical being has its counterpart in her mental development, also. The child's outlook on life has shown a vast change and she is learning to use those powers of mind which are responsible for right development physically, mentally and morally.

CHAPTER LXIV

CONSTRUCTIVE TECHNIQUE

The Orthodontist a Skilled Constructive Technician.—The necessity on the part of the orthodontist of a high degree of technical skill in constructing appliances and adapting them to the requirements of the individual case is more evident now than at any period in the history of orthodontia in spite of the numerous ready made appliances advertised as easily adapted to the teeth, and the prediction of the author that "the orthodontist of the future must be a constructuve orthodontist" has been realized.

The so called ready made appliances are only partially adaptable to the teeth in any event, and, when used by the skilled orthodontist, represent only unit parts which fit into a general scheme for appliance construction which involves the addition of other specially constructed parts and the reconstruction or adaptation of the ready made parts.

For example, the clamp band of all ready made sets, although seldom used in preference to the plain molar band, usually requires a disassembling of the buccal tube, and its realignment, and all incisor, cuspid, and bicuspid bands need to be specially made for the individual teeth.

Again the construction of plain bands for molars in preference to the clamp bands in the majority of cases, the making of the multiplicity of bands for anterior teeth with attachment of spurs, hooks, eyelets, brackets and tubes, the fashioning and soldering of lingual and labial arch wires and locks and the various auxiliary springs as well as the adjustment of labial and lingual alignment arches in the technique of the newer appliances requires constructive ability of no mean order.

Furthermore, the field of retention, with its unlimited possibilities in the mechanical construction of retaining appliances, requiring a combination of art and esthetics in the production of an efficient and inconspicuous apparatus, looms up before one with a demand for the most consummate skill in the art of construction.

Finally, to the lover of the art of orthodontia, the various phases of constructive technique, in both the mechanical and esthetic features, present considerable scope for skill and originality which enable the operator to attain unusual results in the construction of delicate finely adapted appliances which represent the highest art in his work.

Materials for Construction of Appliances.—The first consideration in a material for the construction of appliances to be used in the mouth should be the selection of a metal or alloy that will be the least affected by the fluids of the mouth, and which in turn will least affect the surfaces of the teeth with which it comes into contact.

Any orthodontic appliance in the mouth interferes more or less with the natural cleansing action upon tooth surfaces of the saliva, and of the tongue and cheeks in mastication, and to minimize this tendency, an appliance should not only be simple in design and application, but should be constructed of materials which will give the greatest immunity from caries.

Providing the quality of efficiency is not impaired by such a selection of material, the choice of a metal or alloy for appliance construction is of paramount importance, the manner of its application and subsequent adjustment being of lesser moment.

So many different metals have been advocated in the past for the construction of appliances that it is necessary to point out from the standpoint of clinical experience those metals or alloys which are of the greatest advantage for use in the mouth, where physiological conditions must be taken into account.

German silver was used to the exclusion of almost every other metal or alloy for many years in the United States, and for mechanical efficiency, except in the possession of the requisite tempers for the manufacture of alignment arches and bands, was almost an ideal material for the purpose.

German silver, however, is acted upon by sulphuric, hydrochloric, and nitric acids; even a weak acid like acetic acid will attack it, forming a combination of the basic acetates of copper, which at least is not desirable. Pyrozone and iodine attack it vigorously.

In the mouth German silver discolors and in a large number of cases corrodes upon the surface, sometimes to the extent of perforation of a molar anchor band. The pits formed by this corrosion become breeding places for bacteria, retaining a certain amount of the soft foods in their cup-like pockets.

Potassium sulfo-cyanate, which is normally present in the saliva, and which gives immunity to caries when present in sufficient quantity, badly discolors German silver.

German silver will sometimes leave upon tooth surfaces a metallic stain which is difficult to remove, unless careful prophylactic measures are taken during the treatment of a case.

From a physiological standpoint, then, there is much to be desired in a combination of metals for appliances to be used in the mouth other than is possessed by the alloy of German silver. A material which will not

discolor nor corrode, and which is not attacked by the fluids of the mouth, at the same time possessing the requisite temper for all the parts of an appliance, is much to be preferred.

Gold and Platinum Alloys.—The alloys of gold and platinum possess all these requisite qualifications, and are made up in the form of band material and wire, possessing high degrees of temper and high fusing points.

The alloys of gold and platinum will neither corrode, discolor, nor be affected by any acid or alkali, except aqua regia. The fusing point of platinum is 1775° Cent., of gold, 1075° Cent. An alloy composed of 90 per cent gold and 10 per cent platinum fuses at a temperature of 1130° Cent., which is very significant, proving that *pure gold* may be used as a *solder* upon this alloy without danger of fusing the latter, since the fusing point of the alloy is 55 degrees higher than the fusing point of *gold*.

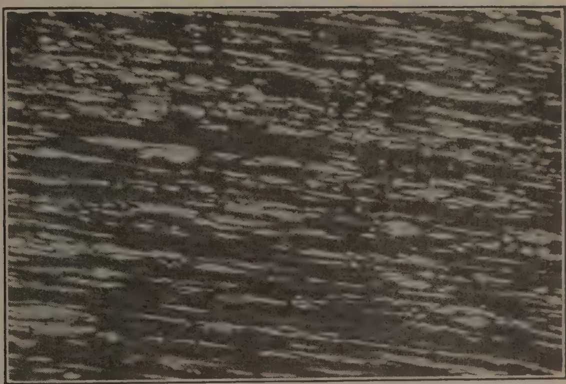


FIG. 1029.—Longitudinal section of typical complex platinum alloy wire. *R. V.* (*Williams.*)

The points of chief importance in a gold alloy for appliance construction are that it shall contain sufficient platinum so that the fusing point will be high enough so that the ordinary blowpipe flame will not melt it while soldering, that it will not oxidize to any degree, and that it shall have the requisite temper and tensile and torsional strength and elasticity. Gold alloys without platinum can be used, but invariably when soldered attachments are made to the arch in these alloys, if anything higher than 18k solder is used, the gold alloy is in danger of being melted. The distribution of the platinum should be uniform, so that a micrograph of a longitudinal view of the wire should appear homogeneous as illustrated in Fig. 1029, a sample of a complex platinum alloy wire prepared by Mr. R. V. Williams in some original research tests at the laboratory of the Williams Gold Refining Co.

In these tests it was also determined that if a finished appliance was plunged while hot into water or pickling solution there was a loss of 12 per cent of its effectiveness. If the appliance is boiled in acid pickling solution after air cooling, there is a loss of 6 per cent of its effectiveness. All wires should be annealed to a cherry red before handling, and should be plunged while hot only in case the wire is tempered afterward. The finished appliance should be cooled in the air, and not placed in an acid pickle to remove oxide. Soda, pumice or potassium cyanide may be used, or the appliance may be boiled in alum solution.

For perfect tempering it has been suggested by the same investigator to heat the appliance on a hot plate at a comparatively low temperature (350° F.) for five or ten minutes, which will give 30 per cent additional effectiveness.

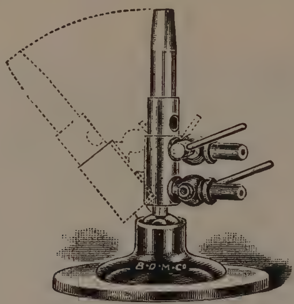


FIG. 1030.—Combination blowpipe and Bunsen burner. (*Designed by Dr. J. Lowe Young.*)

With platinum alloyed with the gold in proper proportion, soldered attachments may be made to an arch of the alloy with 22k solder and even pure gold.

Soldering Requirements.—The attainment of skill in constructive technique in orthodontia lies chiefly in one's ability to perform difficult soldering operations in a rapid and efficient manner, involving a training of the eye as well as the hand in the building up of the units of a given appliance.

This technique of the orthodontist is not up to date without every facility for easier and more rapid methods of soldering than are obtainable by the investment of pieces to be united, or the approximation of parts by the use of bulky tweezers, and the use of the large flame of the Bunsen burner.

The requirements for this class of soldering operations are as follows:

1. A blowpipe with flames of proper fineness and easily controllable.
2. Clean, bright surfaces on parts to be united.
3. Easy flowing solders, in convenient form for use.
4. A quickly acting flux in convenient form to apply.
5. Close approximation and fixation of parts to be united.

6. Proper application and quantity of heat to parts to be soldered.

7. Attainment of accurate rest positions of arms, wrists, hands and fingers for hand soldering.

1. **The Blowpipe.**—Taking up these requirements in order, the form of blowpipe should receive the first consideration. The necessities of the work require that a blowpipe should not be more than a few inches in height, the burner to be upon a substantial base, and having attached to it easily adjustable valves for both gas and air, the tip of the burner being so constructed that a continuous flame of sufficient intensity and fineness may be obtained, and varied in size and intensity by valve control of gas and air to suit the needs of the varying size and bulk of appliances to be soldered.

A blowpipe which most perfectly answers these requirements, Fig. 1030, is the invention of Dr. J. Lowe Young. The burner pillar is in sections, having a ball and socket at its lower end to enable it to be revolved in the base in any direction desired, and from a vertical to a horizontal position, a great advantage in soldering appliances. By turning a ring, and closing an air valve, a Bunsen flame is secured.

A compressed air outfit is most desirable in connection with a blowpipe of this kind, as the ordinary bellows will not answer the purpose, the use of the foot in pumping moving the whole body enough to seriously disturb the soldering operations. The flame of the blowpipe should receive the next consideration, for upon its color, size, shape, and intensity is based all of the accurate work in fine soldering operations in orthodontia. The *blunt conical flame* c, Fig. 1031, is a blue flame, actual size, for average use in hard soldering operations. This flame is an all blue blunty pointed flame of very delicate intensity. This flame and the *sharp conical flame* d, Fig. 1031, are the flames which the orthodontist should be most familiar with, for he uses them in all of the hard soldering technique.

The hottest part of a flame is its tip, and the flames of c and d differ in this respect as much as in their volume or size.

The volume or size of the flame should be governed by the bulk of the metal parts to be soldered, the larger the parts the larger the flame should be. The c flame of an all blue color and bluntly conical, and of medium intensity, is used for hard soldering of wires of .030 inch to .040 inch diameter when soldered joints are at least one-eighth of an inch apart. If wires of a larger diameter than .040 inch are to be soldered, the volume of the flame should be increased, retaining the bluntly conical shape, the color, and intensity of the flame.

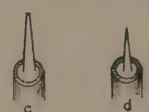


Fig. 1031.—Blowpipe flames for average use.

The *sharp conical flame* d, Fig. 1031, is produced by turning down the gas of the c flame, and turning on more air until a slight hissing sound is pro-

duced, and then slowly reducing the air pressure until the hissing sound ceases. This sharp conical flame is used where soldered joints are less than one-eighth of an inch apart, and being intensely hot, the needle like point of the flame heats up only a small section of the wire on either side of the joint to be soldered, thus enabling one to solder a number of joints on a wire very close together.

2. **Clean Bright Surfaces to be Soldered.**—A clean, bright surface is always essential to a successful attachment of solder, and oxidized surfaces should be carefully polished with a fine sandpaper disc in the engine before soldering, or boiled in acid or alum solution and polished on the lathe.

3. **Easy Flowing Solder.**—While the higher carat gold solders (18k to 22k) in sheet form may be cut up to any requisite degree of fineness for making the various soldered attachments the use of solder in the form of fine wires is very convenient although not superior to cut sheet solder.

These wire solders should be cut up in convenient lengths with a ring at one end as in Fig. 1032 to distinguish them readily from platinum and gold alloyed wire.

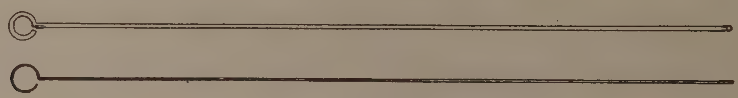
a
b


FIG. 1032.—Forms of wire solder.

With this form of solder, there is a great saving of time, as the end of the wire solder has only to be touched to the surface of one of the parts of an appliance to be attached, when a sufficient quantity will be fused in the required position. In the use of the sheet form of solder, besides the number of motions required to pick up and place a small piece of it in position, it is continually slipping off from the appliance and lost, an annoyance not encountered with the wire solder, although it possesses the advantage of being always used in the minimum amount which is not always possible in the use of the wire solder.

Easy flowing gold solders in wire form of .030 inch and smaller in diameter are now obtainable at the dental depots.

In the use of the gold solders for making attachments upon gold and platinum appliances, an intelligent selection of one of the higher carats (22k) in the uniting of primary parts, with the consecutive use of a lower carat (18k) for secondary attachments, will give assurance of the success of each soldering operation in their order, and if the degree of heat is properly gauged, the union of a number of very small parts in close approximation may be much more safely accomplished than if but one grade of solder were used. It is possible, however, to become so adept

that most of the soldering of gold and platinum appliances may be done with one grade of solder. In soldering iridio-platinum, pure gold must be used as a solder and it can also be used in wire form to advantage.

4. A Quickly Acting Flux in Convenient Form.—Next in importance in soldering operations is the use of a flux which will quickly cleanse the

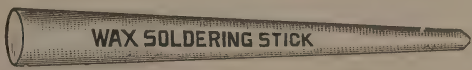


FIG. 1033.—Wax soldering flux.

oxidized surfaces so that the solder will flow readily. Borax is the usual constituent of all fluxes for hard solders of either gold or silver, and when properly calcined and prepared for convenient use, will answer every purpose. A favorite method of some operators is to have a specially prepared borax slate with various sizes of solder mixed with creamed borax on its surface, ready for immediate use. Considerable time is consumed in mixing the borax before every soldering operation in this manner, and the displacement of the solder from position when placed in the flame is an annoying and not infrequent occurrence.

To overcome these difficulties, the author has combined a flux in a specially prepared wax soldering stick, of the size and shape shown in Fig. 1033, and containing a calcined borax flux, which is not only instantaneous in application, but by means of the wax body fixes cut pieces of solder in position so that they cannot be displaced before fusion takes place. The only caution necessary in its use is that the surface to be soldered should be slightly warmed, and not heated to redness, before touching with the wax stick. Borax fluxes incorporated in a vaseline base are also to be obtained in the depots and give very satisfactory results.

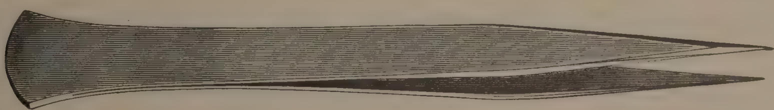


FIG. 1034.—Solder tweezers.

A pair of solder tweezers of the size and shape shown in Fig. 1034, should be used for picking up pieces of solder, and its point should be kept clean and out of the soldering flame in order to be in proper condition to use.

For cutting gold and platinum, iridio-platinum, and sheet solder, a pair of small shears with especially strong blades, such as is illustrated in Fig. 1035, is especially adapted for use in the operating cabinet.

5. Close Approximation of Parts to be Soldered.—Another essential for good soldering is the perfect approximation of the parts to be soldered,

so that the minimum quantity of solder may be used, thus forming the strongest union, and the easiest to solder because of the capillary attraction of the fused solder between the smooth surfaces in close contact. An

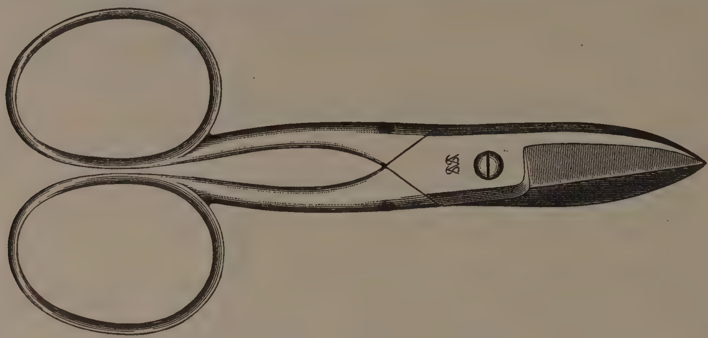


FIG. 1035.—Gold plate shears.

illustration of the perfect approximation of wires for soldering is shown in Fig. 1036, a and c, while imperfect contacts which will be less perfectly

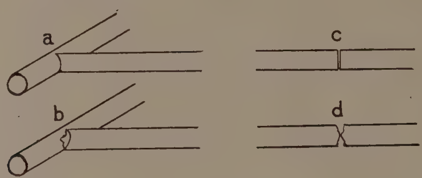


FIG. 1036.—a and c—close approximation of parts to be soldered. b and d—imperfect contacts.

soldered are shown at b and d in the same illustration of an enlarged drawing of the wires.

6. Proper Application and Quantity of Heat to Parts to be Soldered.—In the proper application of the heat from the blowpipe flame to the parts to be soldered it should be noted that the wire, Fig. 1037, or the part of the appliance upon which the solder is to be flowed is to be heated (not the solder) in the tip of the flame until it is as hot as the fusing point of the solder, which will then melt and flow upon the surface. The novice always makes the mistake of heating and melting the solder upon the surface of a cooler metal and fusion of the two fails.

7. Attainment of Accurate Rest Positions of Arms, Hands, and Fingers for Hand Soldering.—The seventh and final requirement for successful hand soldering is the attainment of rest positions of arms, wrists, hands, and fingers while holding the delicate pieces of wire or bands in the flame during the soldering operation. In the first place, if the operator is standing, a high cabinet top is essential so that the work to be done will be near enough to the eye to be easily seen while the body is in an erect position, alway a rest position for the spine rather than a stooped position.

The blowpipe should not be nearer the front edge of the cabinet top than six inches, giving space for the whole of the hands and wrists to extend between the blowpipe and the edge of the cabinet top.

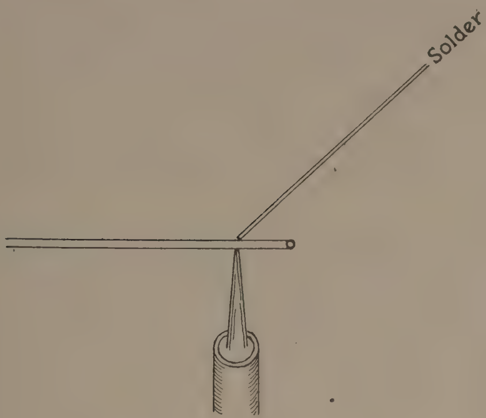


FIG. 1037.—Heating of wire for flowing solder on the surface.

The forearms, extending upward at a slight angle, should rest on the edge of the top of the cabinet for steadying the arms and hands, the latter pivoting up or down at the wrists which are thus free to move at the joints.

The hands are further steadied, as shown in Fig. 1038, by holding the

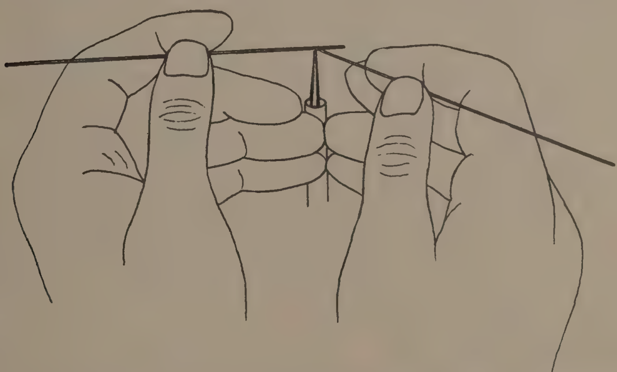


FIG. 1038.—Rest positions of hands with fingers touching during soldering operations.

tips of the third and fourth fingers of each hand in contact, while the first and second fingers and thumb of each hand hold the wires or other parts to be soldered in approximation in the tip of the flame, the hottest portion for hard soldering.

Various other positions of hands and fingers are necessary for hand soldering and will suggest themselves to the operator after he has gained adeptness in soldering with the positions of the arms, wrists, hands and

fingers as already described, after which he is ready to proceed with the construction of bands and other unit parts of appliances.

Orthodontic Soldering Clamps.—A number of years ago, the author devised a set of delicate clamps, Fig. 1039, for the approximation of the various parts of bands and appliances while being united with solder, and twenty years of constant use and improvement have brought them up to a standard of perfection which makes the operation of soldering extremely simple, accurate and rapid, and their use can be combined with the hand soldering methods just described. There is hardly a single practical

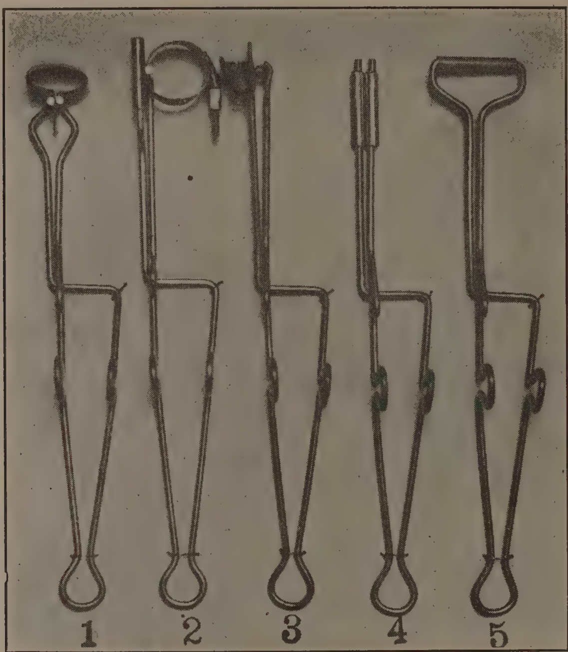


FIG. 1039.—The author's soldering clamps.

combination of appliance parts that cannot be perfectly adjusted in these clamps.

Construction of Plain Bands for Incisors and Cuspids.—One of the most important adjuncts to the direct application of force to the upper and lower anterior teeth, is the plain band, or Magill band as it is often called after its originator.

Plain bands may be made of gold and platinum of .003 inch thickness, and of an average width of .09 inch. Plain bands may be made of iridio-platinum .003 inch in thickness and of an average width of .19 inch, as this material can be used much thinner than the gold and platinum material,

and will occupy correspondingly less space between incisors where all of them are banded.

Gold and platinum band material is now furnished by the manufacturers in strips of the form shown in Fig. 1040 in any length desired.

The band material should first be formed into a loop, the edges of which are forced between the mesial and distal approximating surfaces of the tooth to be banded and the adjoining teeth, the free ends directed lingually or labially as desired, and after pulling the band material taut on the tooth, it should be removed and the proximal edges festooned so

FIG. 1040.—Band material in strip form.

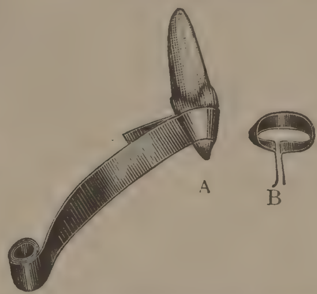


FIG. 1041.—A. Band material pinched around an incisor with band forming pliers. B. Pinched band after removal, ready for soldering.

that they pass just beneath the labial and proximal gum margins. The ends of the loop should then be pinched together close to the tooth surface, as at A in Fig. 1041. The ends of the band material should meet at right angles at the point of union, so as to form a continuous inner surface of the band when soldered, as at B in the same cut.

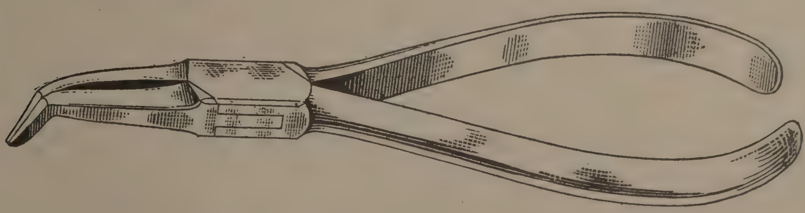


FIG. 1042.—The author's band forming plier.

The author's band-forming pliers, shown in Fig. 1042, are especially designed for this purpose, having concavo-convex beaks which accurately fit the surfaces of the teeth. Fig. 1043 A illustrates the nicety with which the concave edge of the beaks fits the labial surface of an upper incisor, when the pinch is made on the labial surface, and B the accuracy with which the convex edge fits the lingual surface of a lower incisor.

The plain band should be fitted closely to the tooth surface, for there will always be sufficient space for the cement for proper fixation of the

band and protection of the tooth surface. The burnishing of the margins of the band may be done while it is still held in position by the band forming pliers. Oftentimes, in forming the cuspid band, it is necessary to make an additional pinch at the mesial and distal angles, filling the pinched portion with solder and trimming off the projecting edge.

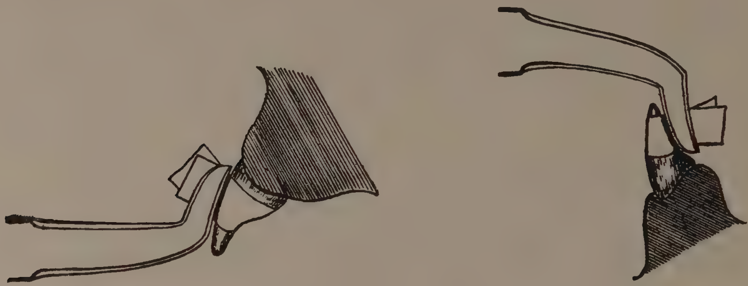


FIG. 1043.—A. Pinching band on labial surface of upper incisor. B. Pinching band on lingual surface of lower incisor.

Soldering the Band.—In uniting the ends of the plain band with solder, they should be held in a suitable plier, or in an automatic clamp as in Fig. 1044, and having been fluxed, the band is held in the fine flame of the blowpipe, a piece of wire solder touching the edges of the joint until it is fused. The surplus ends are next cut off, and the ridge which remains polished smooth with the sand-paper disc, after which the band, if of gold and platinum, is transferred to a boiling solution of acid or

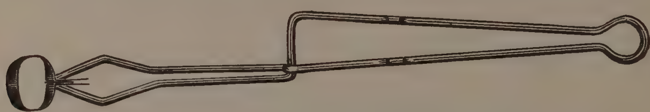


FIG. 1044.—The author's soldering clamp.

alum to deoxidize it, and then polished. The edges of the band to be united may be beveled, lapped and soldered so that there is no joint evident, thus having the appearance of a seamless band. If it is not to be cemented on at once, the band should be properly indexed and filed until the next sitting. Iridio-platinum band material should be roughened by drawing it over a round file No. 3 cut, leaving a surface to which the cement will better adhere.

Accessories to the Plain Band.—As the plain band is usually utilized for the more direct attachment of ligatures, and for retaining appliances, as well as for lever tubes and traction screw tubes, the various methods of making these attachments should be carefully studied. Where the banded tooth does not need rotation, but simply a direct movement toward

the arch, a notch in the seam of the band will prevent the ligature from slipping, as at A, Fig. 1045.

Lingual spurs for rotation may be attached as at B, Fig. 1045. The band should be held in a tweezer or a No. 1 clamp in the left hand, and a length of wire solder adjusted with the right hand at the point at which it is desired to attach the spur, and the band held in the flame until the end of the wire solder fuses, when the band is quickly removed, the surplus solder cut off, leaving a short extension of the solder itself as a spur for the attachment of ligatures. Eyelets and hooks may be formed of .025 inch wire and held in position on the plain band with the No. 1 clamp.

The retaining spur shown at D, Fig. 1045, is attached as follows: a length of the retaining wire is held against the band with the right hand,

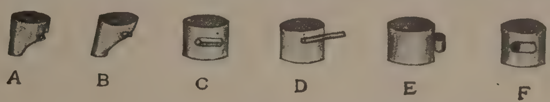


FIG. 1045.—Various attachments to the plain band.

the surface of the band having had a small piece of solder fused upon it previously. The band itself is held in a tweezer or the No. 1 clamp of the set shown in Fig. 1039.

The lever tube at C, Fig. 1045, preferably square, is cut off the desired length and held in approximation with the surface of the band by the No. 3 clamp alone of the set shown in Fig. 1039.

Larger sized tubing for the ends of the traction screw, as at E and F, Fig. 1045, may be adjusted to position with the Nos. 2 and 4 clamps, as illustrated in Fig. 1039. The short tubes may be held in the tip of the No. 4 clamp at any desired angle to the band while being soldered, being especially useful in the attachment of the tube at one corner of a cuspid band for the end of the traction screw.

Hooks and Spurs for the Alignment Arch.—For convenience in use, and saving of time at the chair, a number of pieces of iridio-platinum, and gold and platinum wire of several different sizes, from .030 inch to .030 inch in diameter and about ten or twelve inches long, should be kept in stock.

FIG. 1046.—Soldering hook to the alignment arch.

Hooks may be easily made by bending a step in the end of one of these wires as shown in Fig. 1046, the end soldered to the alignment arch in the desired position, and the surplus wire cut off.

Spurs for the alignment arch should preferably be made of the 18k wire solder, attached similarly to the spurs on plain bands.

Indirect Methods of Making Plain Bands.—The importance of constructing plain bands for molars or other teeth so that the band will fit the contour of the crown closely, being projected at the same time very slightly under the buccal and lingual gingival margins, and festooned mesially and distally so that it will not injure the peridental membrane nor the free margin of the gingivæ, has led many operators to adopt an indirect method of making these bands whereby such protective construction is especially provided for.

One of these indirect methods in which the idea of protection of these delicate tissues is strongly stressed in the manner of band construction is described by Dr. A. P. Rogers as follows:

The Rogers Indirect Method of Making Plain Bands.*—"The tooth which is to be banded must first undergo a thorough prophylactic treatment after which an accurate plaster impression is taken as shown in Fig. 1049. When this has been removed from the mouth, the operator care-

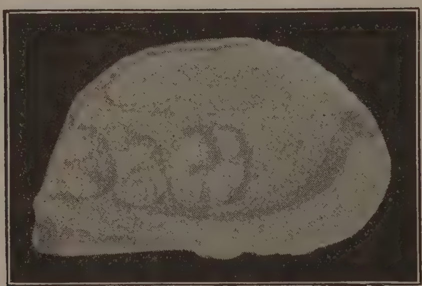


Fig. 1047.—Impression of first molar.

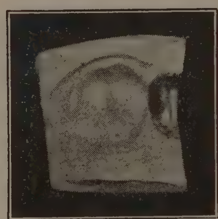


Fig. 1048.—Impression trimmed to approximation of first molar.

fully investigates the gingival tissue to ascertain the amount of free gum margin which is present. This is necessary especially in the treatment of children when the first molar is to be banded, and where there is usually an excess of tissue. Careful note is made of the depth of the gingival pocket, and the operator determines just how far it is safe to allow the margin of the band to extend under this soft gingual tissue, always remembering that it must be a safe distance away from the bottom of the pocket when the band is cemented in place."

"In young cases the operators must bear in mind that the soft tissues are rapidly absorbed and the margin of the band must extend deeply enough into this pocket to protect the enamel surface when this natural absorp-

*Orthodontic Appliances and Gingival Tissue. By Alfred P. Rogers, Journal of the National Dental Assoc., April, 1919, p. 330.

tion takes place. The distance that the band is intended to thus extend under the free margin of the gum is indicated on the impression both buccally and lingually by a pencil mark."

"Before the impression is varnished it is trimmed down to the point indicated by the pencil mark and at right angles to the long axis of the tooth as shown in Fig. 1048. The impression is then varnished with shellac and set aside to dry. When the shellac is thoroughly dry, the operator takes a cylindrical pencil of modelling compound about one-half inch in diameter, as shown in Fig. 1049, warms one end to uniform depth in the

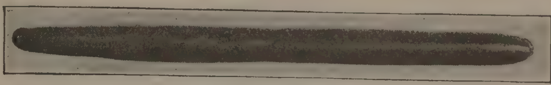


FIG. 1049.—Modelling compound pencil for obtaining die of first molar from impression

Bunsen flame, leaving a hard core in the center. Passing this softened end from the flame into a receptacle of vaseline, it is immediately forced into the tooth impression, taking care that the pencil is held in the direction of the long axis of the tooth."

FIG. 1050.—Die of modelling compound after removal from impression.

FIG. 1051.—Die of modelling compound after trimming (buccal surface).

"When sufficiently hard, the compound die is removed from the impression and cut off about an inch in length as shown in Fig. 1050, and it will be observed that the buccal and lingual planes at right angles to the axis of the tooth indicate the points at which the carving of the compound representing the soft tissue shall terminate; as already explained, these planes represent the depth below the free margin of the gum tissue that the operator has previously decided that it is safe for the molar band to project."

"After trimming the base to an artistic hexagon pattern, Fig. 1051 the operator then proceeds to carve away from the tooth surface the compound representing the gingival tissue. This carving must be so carefully done that the enamel surfaces represented by the compound model are not changed nor marred in the least. Next, in the mesial and distal carving,

the base lines are allowed to curve occlusally, Fig. 1052 being continuous with the buccal and lingual planes. This surface, which is always carved at right angles to the long axis of the tooth, is termed the "seat," and determines the length and form of the gingival surface of the band."

"Just below the gingival border the surfaces representing the enamel are next scraped away both lingually and buccally, so that the bucco-lingual diameter at this point is from one to two hundredths of an inch less than

FIG. 1052.—Compound die after trimming gingivally on proximal margins.

on the actual tooth. Thus, when the completed band is adapted to the tooth, a slight spring is necessary to force it to place, which greatly adds to the nicety of the fit. The festooning of the mesial and distal surfaces makes possible this exact adaptation. Upon completion of this carving, the compound model receives a thin coat of varnish, and when sufficiently dry, is invested in a bed of plaster to which a small amount of sump

A B C

FIG. 1053.—Paper cylinder (A) into which investment (B) is poured, and (C) after removal of compound.

has been added. This investment is first poured into a paper cylinder a little deeper than the height of the compound die, and when the investment is sufficiently hard, the compound is softened in hot water and very carefully removed from it as shown in Fig. 1053."

"The investment is then allowed to dry and is later filled with Melotte's metal. A much smoother surface is obtained if the operator will, while the metal is in a semi-molten state, carefully tamp it down with a plunger

made from a tight roll of cotton. It will be found in following this procedure that the metal presents a smooth, bright surface to which the molar bands can be beautifully adapted." Fig. 1054 is a drawing of the die after removal which more sharply defines the trimming of the gingival margins and the artistic pattern of the case.

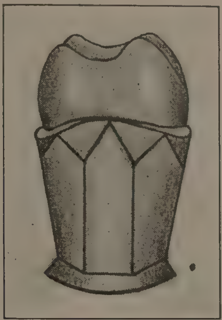


FIG. 1054.—Drawing of completed metal die sharply defining the gingival trimming.

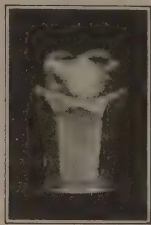


FIG. 1055.—Metal die with band in place.

"When this stage is reached the operator may proceed by whatever method he wishes to construct the molar bands, but, whether it be swaged or burnished, he must see that it is properly seated and perfectly adapted to the enamel surface, especially at the gingival border. Fig. 1055 represents

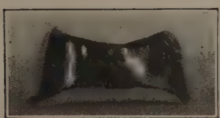


FIG. 1056.—Molar band after removal from the die.

FIG. 1057.—Section of molar tooth with band in place showing adaptation at gingival margins.

the metal die with the band in place. Fig. 1056 exhibits the molar band after its removal from the metal die, and ready for whatever attachments the orthodontist wishes to place upon it.

"Fig. 1057 represents a longitudinal section of a molar tooth with the band in place, showing a band which has been in actual use in the mouth for over a year, the impression being taken with the band in position on the tooth. The gingival edges of the band will be seen projecting into

the gingival pocket, the free margin of the gum being normal and in perfect contact."

The buccal tubes may be soldered upon the plain bands on the first molars and the alignment arch adjusted and aligned upon the plaster cast, so that at the second sitting of the patient, the molar bands may be cemented in place and the alignment arch adjusted upon the natural teeth. The method described has many advantages, chief of which are the

FIG. 1058.—Graduated sizes of copper bands.

greater comfort for the patient, and the expenditure of a minimum amount of time in fitting the appliance to the natural teeth.

Dr. Waugh's Indirect Method of Making Molar Bands.—Believing that the inlay and crown technique of the dental prosthestist presented methods of the greatest accuracy and preservation of oral tissues, Dr. L. M. Waugh has adapted an indirect method for making molar bands which follows out these general principles of prosthetic construction accepted by the most exacting dental practitioners.

"In the experience of this writer, coin gold and more pliable gold alloys, in thickness of .006 inch, are not sufficiently strong for anchor bands. Reinforcements of solder in the buccal and lingual grooves, or a line of solder tossed around the occlusal edge, strengthen that margin but do not

prevent a band from stretching along the cervical edge, the strain from the leverage of the arch wire being as great there as at the occlusal edge. Metals commonly known as "gold-platinum alloys" have given greatest satisfaction." *

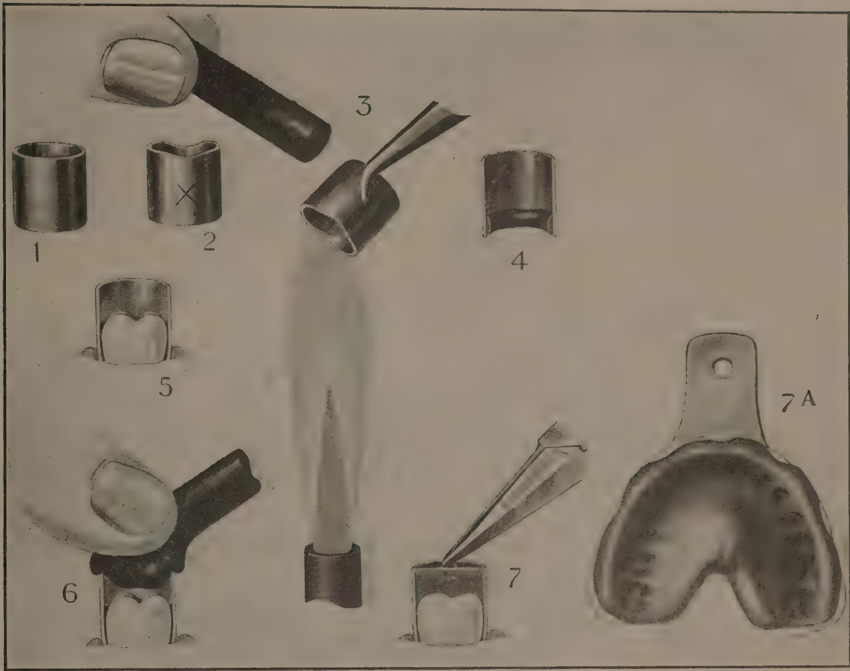


FIG. 1059.—Technique for taking copper band impressions of molars. (*After L M. Waugh.*)

The technique adopted by Dr. Waugh will be described in two parts: 1. The Chair Technique. 2. The Laboratory or Bench Technique.

It is assumed that casts for study, radiograms of the entire jaws and the diagnosis have been made, appliances planned, and the separation of teeth to be banded previously accomplished in the preferred way.

With patient in the chair the progressive steps are:

"(a) Spray the mouth and remove separating ligatures."

"(b) Cleanse anchor teeth thoroughly to remove food debris and micro-organisms by scrubbing the surfaces by means of a tightly rolled pledget of cotton carried in tweezers, moistened with an efficient germicide and dipped into flour of pumice. This may be supplemented by a small bristle brush carried in a hand porte polisher. The bristles should be cut to about 3 or 4 mm. in length. Thoroughly spray teeth and gum margins."

*Indirect Method of Making Orthodontic Appliances, by Dr. L. M. Waugh, read before American Society of Orthodontists, April 24, 1922.

"(c) A box of graduated sizes of copper bands for molars, Fig. 1058, should be kept in stock. Select a copper band 1, Fig. 1059, that will nicely slip over the crown, shaping itself to the general outline."

"(d) Remove from the mouth, scratch the mesial surface to distinguish it, and trim concave the cervical edge of the band on the mesial and distal sides. With curved beak pliers, turn the cervical edge of band slightly inward, as shown at 2, Fig. 1059."

"(e) Replace on the tooth and press just to the free margin of the gum. Scratch distinct line parallel with the gum margin going well into the embrasures."

"(f) Remove and trim the cervical edge with curved shears following the scratch, file smooth and with curved beak pliers turn inward the cervical edge."

"(g) Replace on the tooth, press nicely beneath the free margin of the gum, and with the Young band adapters press the cervical edge close to the tooth all the way around. Scratch a line following the gum margin. Remove and trim so that the band goes the proper distance beneath the gum. In the fully erupted tooth, this should be approximately 1 mm. on the buccal and lingual, and 2 to 3 mm. on the mesial and distal edges. In partially erupted teeth, it may extend farther."

"(h) Replace and with band adapters press the cervical edge close to the tooth."

"(i) Remove the band, grasp the occlusal edge with soldering pliers and heat in flame, as at 3, Fig. 1059, then melt a ridge of modeling compound about 4 mm. in width from a cool stick around the inside of the cervical edge of the band as at 4, Fig. 1059. When just cool enough to permit holding the band in the fingers and not burn the gum, press quickly on to the tooth nicely beneath the free margin of the gum, as at 5, Fig. 1059, keeping it dry while warming the end of a stick of compound in the flame and place it into the occlusal end of the band, pressing it quickly and firmly with the moistened thumb or forefinger, as shown at 6, Fig. 1059, or a piece of No. 60 tinfoil, at the same time removing the excess of the stick. If this is done quickly, the two parts of compound will fuse and no joint will be discernible. Maintain pressure for a half minute until the compound has partly cooled. With Howe pliers as at 7, Fig. 1059 press the compound away from the band at a convenient place along the buccal or lingual margin so as to form a place for a firm grasp in later removing the band containing the impression. Chill with compressed air or cool water. When thoroughly hardened, make a distinct scratch around the band following accurately the gingival margin, then grasp with Howe pliers and draw the impression *straight off* the tooth. It *must not be wiggled* as this would result in enlarging the impression with the conse-

quence that the die would be too large and the resulting band be too big for the tooth. Observe the distance the band extends beneath the gum, all the way round, carefully cutting off any excess with a file."

"This is repeated with all of the anchor teeth, usually four in number."

"(j) After the last copper-band impression has been removed, accurate impressions of the upper and lower jaws are made in modeling compound, the upper being shown at 7A, Fig. 1059.

"(k) Separating ligatures are placed, the mouth sprayed and the patient dismissed."

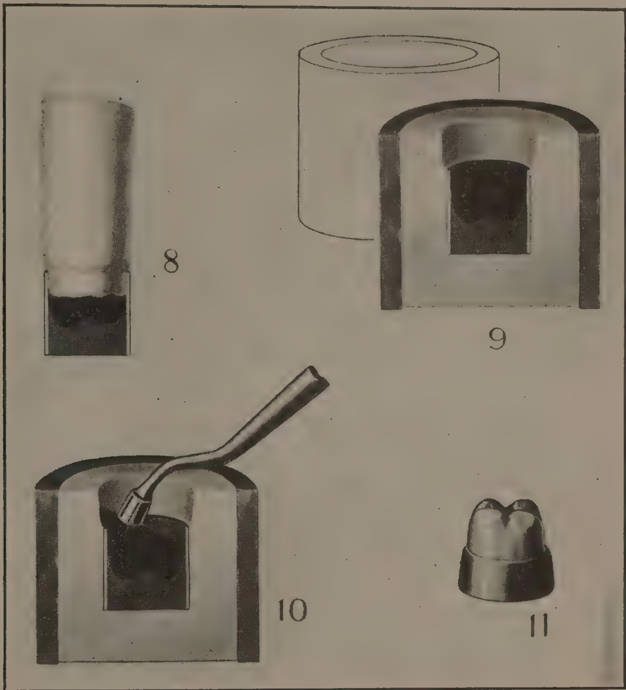


FIG. 1060.—Making amalgam die from invested copper band impressions. (*After Dr. L. M Waugh.*)

"The average time required in daily practice to make four copper-band impressions of anchor teeth, and two compound impressions of the entire arches embracing the steps as outlined above is one hour, be it for a young or older patient. There is no pain or discomfort, therefore no delay. By hurrying, it can often be done in forty minutes. *The case now goes to the laboratory and the anchor bands and arches are made and are ready for insertion at the next appointment.*"

The Laboratory or Bench Technique of the Waugh Method.—*Progressive Steps:*

"(a) A piece of cotton roll 1½″ long is inserted in each copper band impression as shown at 8, Fig. 1060. The roll must fit snugly and bulge slightly at margin of the band. Vaseline the roll near the band to keep plaster from sticking."

"(b) The copper-band impressions of anchor teeth are imbedded in cast plaster, each in a separate rubber ring as shown at 9, Fig. 1060. The copper-band impression is pressed down so that about ⅛ inch of the cotton roll is also imbedded in the plaster. The average time for (a) and (b) combined, is ten minutes. The plaster is allowed to set for about fifteen minutes."

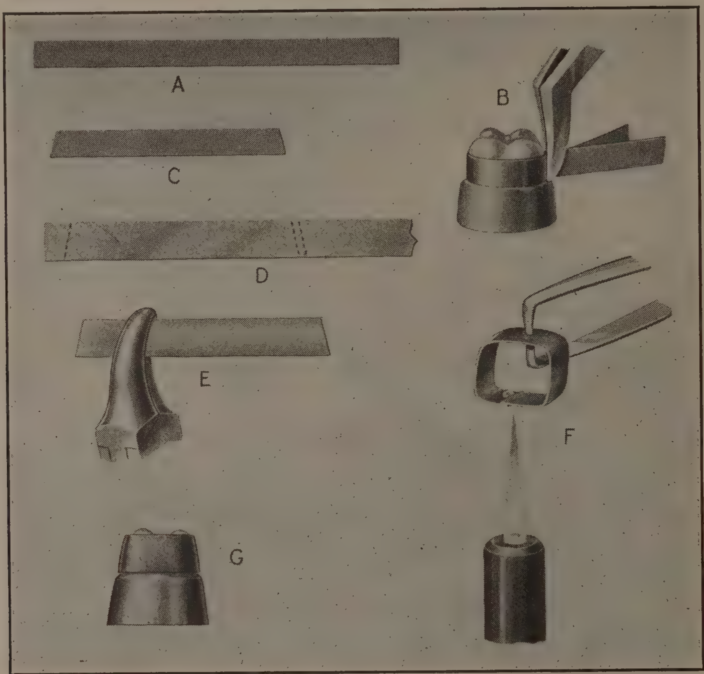


FIG. 1061.—Consecutive steps for fitting gold and platinum band on amalgam die.

"(c) The cotton roll is removed and any sharp edges of plaster are smoothed."

"(d) The impression is now packed with amalgam, preferably of a silver-tin alloy as at 10, Fig. 1060. It is well mixed in a mortar and the excess mercury expressed by placing the mass in a piece of kid or chamois and twisting with the fingers. Pliers should not be used as the amalgam must be quite soft and easy to pack. The average time for four is thirty minutes. The amalgam is allowed to set eight or more hours, usually over night. Copper amalgam may be used, but has the disadvantage of badly staining the fingers."

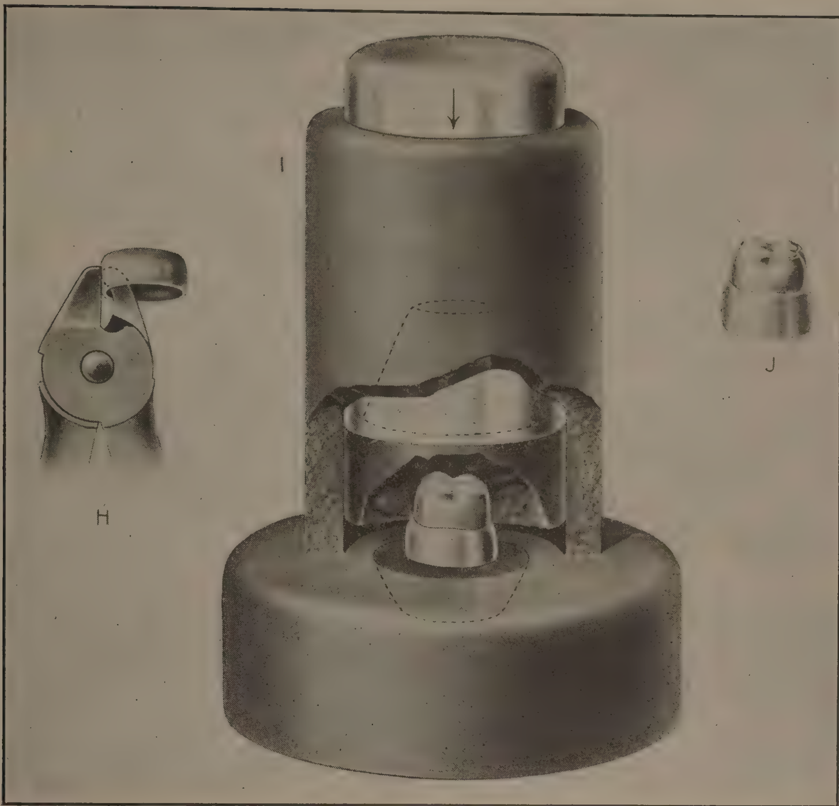


FIG. 1062.—Swaging and contouring fitted gold and platinum band. (*After Dr. L. M. Waugh.*)

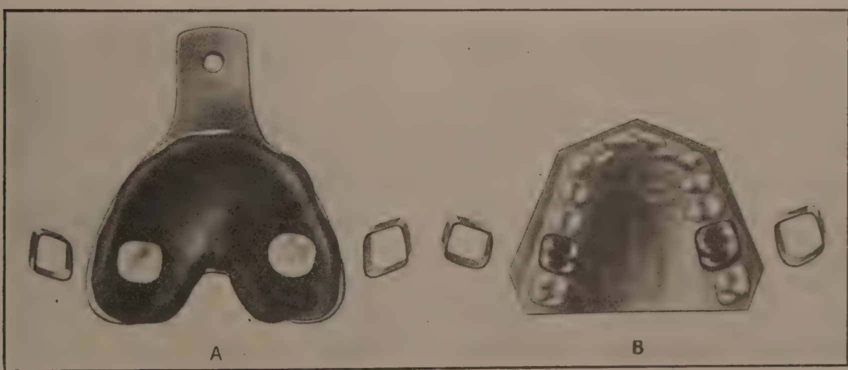


FIG. 1063.—A, Amalgam dies placed in position in impresson; B, cast with amalgam dies in place.

"(e) The plaster and copper-band impressions are separated from the die which is shown at 11, Fig. 1060. The average time for four is ten minutes."

"(f) Making four gold and platinum bands on metal dies, the consecutive steps being shown at A, B, C, D, E, F, and G, Fig. 1061, the final adaptation being made in a swager I, Fig. 1062, followed by pinching and stretching the middle of the band with the Mershon Band contouring plier, H, Fig. 1062. The band swaged to the amalgam die is shown at J, Fig. 1062. The average time for four is one hour."

"(g) The bands are now laid aside and the dies placed in proper position in the compound impressions of the upper and lower jaws, and the impressions poured with cast plaster Fig. 1063, A and B. The average time is ten minutes. The plaster is allowed to set for twenty minutes."

"(h) The modeling compound is softened in warm water and removed and the casts are trimmed. The average time for two is ten minutes."

The total actual time consumed in the laboratory technique to this stage is two hours and ten minutes."

(i) Accurate casts of the entire dental arches are thus obtained. The anchor teeth being of metal, the bands may be placed in position and removed as often as necessary without marring the anchor teeth. If care has been exercised in the various steps the casts will so closely reproduce actual mouth conditions that appliances may be adapted with greatest nicety in the assurance that they will fit equally well when placed upon the teeth."

"After the appliances are completed, the dies of the anchor teeth are removed from the casts and filed alphabetically in cardboard boxes of suitable size. If, for any reason, a new band should be needed, it can, upon notification, be made in advance and be cemented at the next appointment."

Dr. H. A. Bakers' Indirect Method of Making the Plain Band.—Dr. H. A. Baker devised a simple indirect method of construction of the plain anchor band which was published in the early editions of this chapter and presents many valuable features. The method is as follows: Upon a plaster cast of the teeth trim down the second bicuspid and second molar at an oblique angle from their occlusal surfaces to 1/32″ or 1/16″ below the gum line adjacent to the first molar which is to be used for the anchor tooth, as in Fig. 1064. Continue the labial, lingual, and proximate surfaces of the molar of vertical lines into the plaster cast beyond the gingivæ, extending these surfaces to a level 1/32″ to 1/16″ below the gum margins and preserving the contour of the tooth. Varnish the exposed portions of the tooth with shellac to obtain a hard surface.

A plain band is then made to fit the first molar, soldering the joint (off from the cast) upon the lingual surface and afterward burnishing the edges of the band into the grooves and depressions on the labio-occlusal and linguo-occlusal aspects of the tooth on the cast. The upper edge of the band should extend underneath the gum a short distance. The band

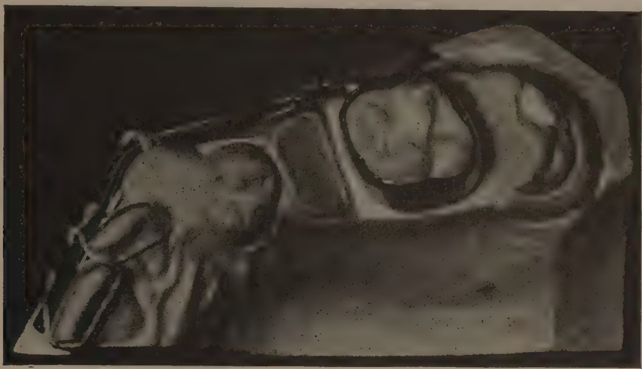


Fig. 1064.—Plain band fitted and contoured to first molar on plaster casts. (*After H. A Baker.*)

should next be fitted to the natural tooth, contouring in the gingival edge of the band enough so that the band will spring over the widest diameter of the crown of the molar. The first molar should be separated from the adjacent bicuspid and second molar so that the plain band will slip over the crown of the first molar freely, this separation being made during the interval between the first and second visits of the patient.

Fig. 1065.—Graded sizes of molar bands for direct method of band construction.

Direct Method of Constructing the Plain Anchor Band.—The author's method of making plain anchor bands consists of a direct method of

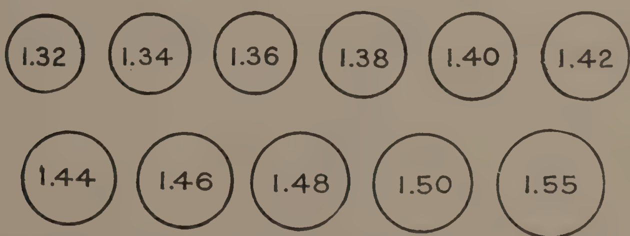


Fig. 1066.—Graded sizes of molar bands shown in circumference.

adapting and contouring the band to the anchor tooth in the mouth. A number of graded sizes of gold and platinum cylindrical bands from 1.32 inches to 1.50 inches, in circumference and previously soldered are kept in

stock, Fig. 1065, ready for immediate use. These sizes for the average permanent upper or lower molars are in length of band material as follows: 1.32 inches, 1.34 inches, 1.36 inches, 1.38 inches, 1.40 inches, 1.42 inches, 1.44 inches, 1.46 inches, 1.48 inches, 1.50 inches, 1.55 inches shown in circumference in Fig. 1066. The ends of these sections of band material before being united are trimmed to certain definite angles for both upper and lower molars, Fig. 1067, a 4° angle on the upper and a 12° angle on the lower molar band as the lower molar has the greater flare.

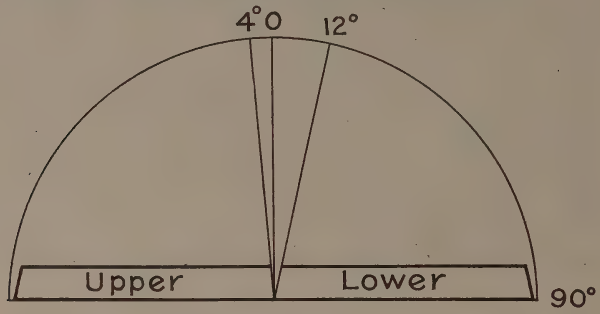


Fig. 1067.—Angles for cutting ends of bands for upper and lower molars.

These bands are made up in pairs of the same length, as the first molars on each side of the mouth are usually identical in size. The average first permanent molar is 1.40 inches in circumference, this measure holding good for all four first molars, hence this size and the nearest sizes, 1.38 inches, and 1.42 inches, will be used the more often from the made up stock. The ends of these cut sections of band material are beveled oppositely with a file, and the band material formed into a cylinder with the bevels lapping. The ends are usually soldered with 18k solder, or with 24k gold, the latter making the union soft and pliable.

A band is selected which when flattened slightly mesially and distally will fit tightly when slipped over the crown of the molar past the contact points. It is then removed and festooned mesially and distally towards the gingivæ, as in Fig. 1068 and the occlusal edge curved inward all

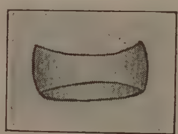


Fig. 1068.—Molar band after mesial and distal festooning and contouring in of occlusal edge.

around, and contoured buccally and lingually, with the plier shown in Fig. 1069 when it is replaced on the molar and rocked into place with the author's band setter, Fig. 1070, and then adapted to the grooves and cusps with the burnishing instrument illustrated in Fig. 1071. The band

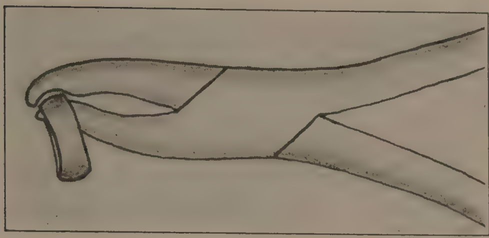


FIG. 1069.—Contouring gingival and occlusal edges of band buccally and lingually.

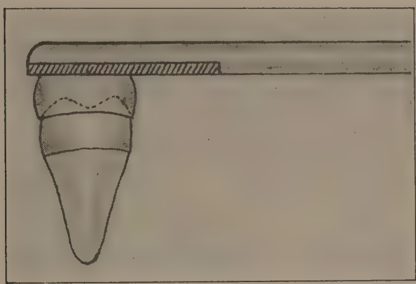


FIG. 1070.—Forcing band to place with band setter.

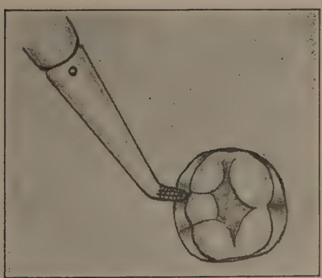


FIG. 1071.—Adapting band to molar with the Young burnisher.

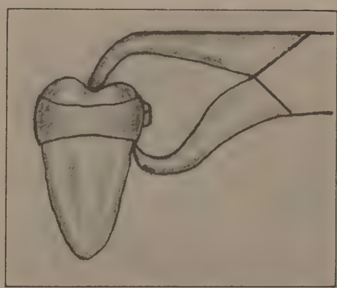


FIG. 1072.—Removing band with the author's band removing plier.

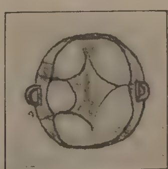


FIG. 1073.—Adapted molar band with vertical tubes attached.

is removed with the author's band removing plier, Fig. 1072, when it is ready for attaching the buccal tubes, lingual wires, etc., as in Fig. 1073.

Soldering Buccal Tube on the Anchor Band.—This operation is one that is frequently done and requires so much exactness that the aid of special clamps is almost indispensable to facilitate rapid and correct soldering of these parts.

Almost all of the molar clamp bands purchased at the dental depots have to be subjected to a change in the position of the tube so as to secure proper alignment of the arch wire as in Fig. 1074.

During the treatment of Class II and III cases, the occasional tipping of the anchor teeth distally and mesially, requires a re-alignment of the anchor tubes occasionally to keep up the efficiency of the anchorage. To prevent the alignment arch from dropping below the edges of the incisors, as at A, Fig. 1074, the anchor clamp-bands should be removed and the buccal tubes realigned so that the alignment arch will rest upon the surfaces of the incisors as at B, Fig. 1074. The technique of this operation is as follows:

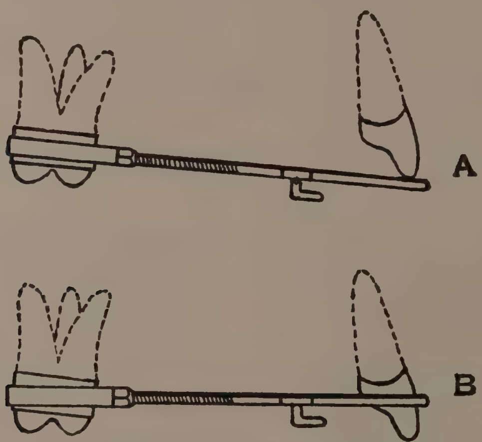


FIG. 1074.—Adjustment of anchor tubes and arch wire.

The molar clamp band is held in a vice-like grip in the dog jaw of special clamp No. 9 Fig. 1075, which is attached to the distal part of the clamp band so as to enable this clamp to be held in the fingers of the left hand, while those of the right control clamp No. 10, which engages the buccal tube, with the mesial end toward the handle of the clamp.

Having previously attached a piece of solder on the buccal side of the surface with the wax flux at the point at which the tube is to be joined, the right angle arm of the No. 9 clamp is placed on the lingual side of the band, and the arm holding the tube is allowed to drop down into position on the buccal surface of the band. The tube is aligned horizontally with

the edge of the band, and then the clamp band and tube are held in the flame of blowpipe until the solder is perfectly fused. The horizontal buccal tube on the plain molar band is aligned in the same manner during its construction and adaptation.

The round or half round vertical tubes for anchorage, as illustrated in Fig.1073, are aligned in a somewhat similar manner to that just described for the alignment of the horizontal tubes, using a specially constructed clamp for holding the vertical tubes in position while soldering.

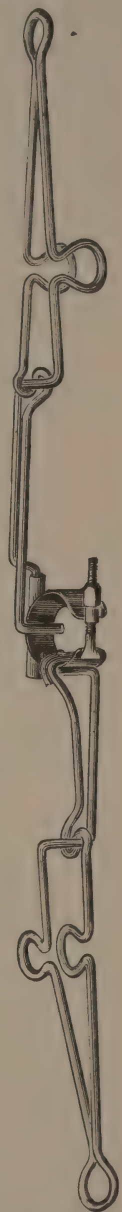


FIG. 1075.—Realigning buccal tube by means of special clamps.

Construction of Appliances on the Plaster Cast.—While it has been the custom of many operators to construct at the chair labial alignment arches attached to buccal tubes or locks on molar anchor bands, fitting the arch wire from the molar on one side to the molar on the other side of the dental arch, bending the arch wire to follow closely the contour of the arch with the expectation of considerable accuracy of fit and alignment of the appliance, it is generally conceded that the construction of all lingual arches in the same manner, while within the range of possibility, is not the easiest nor the most practical method of construction.

Preferably in the construction of the lingual arches it is best to make and fit the anchor bands only in the mouth, taking a compound impression of the teeth with the anchor bands in position, and fitting the anchor bands into their imprint in the impression, and pouring the cast with an asbestos investment material, the molar bands appearing upon the teeth of the cast when the compound has been removed as shown in Fig. 1076.

Laboratory Soldering Stand.—A reversible blowpipe, Fig. 1077, attached to a soldering stand has been made at the suggestion of the author, for laboratory use in cases where appliances are soldered upon plaster casts. By means of the swivel joints of the blowpipe, the flame may be directed upon any portion of the inside circumference of the soldering block, and fixed at any desired position. The position of the blowpipe is under such perfect control that the direction of the flame may be changed from left to right, up or down, on or away from the appliance by a slight pressure on the handle.

The Bach Soldering Stand.—Another soldering stand, devised by Dr. Bach, is illustrated in Fig. 1078. This stand is of great assistance in the laboratory construction of appliances upon

FIG. 1076.—Molar bands on investment cast ready for appliance construction.

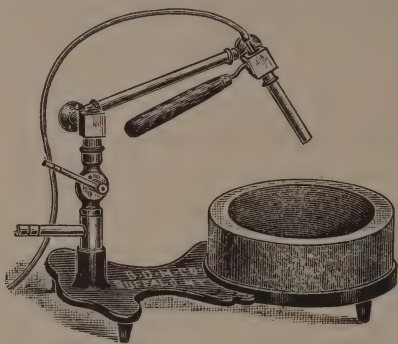


FIG. 1077.—The author's laboratory soldering stand.

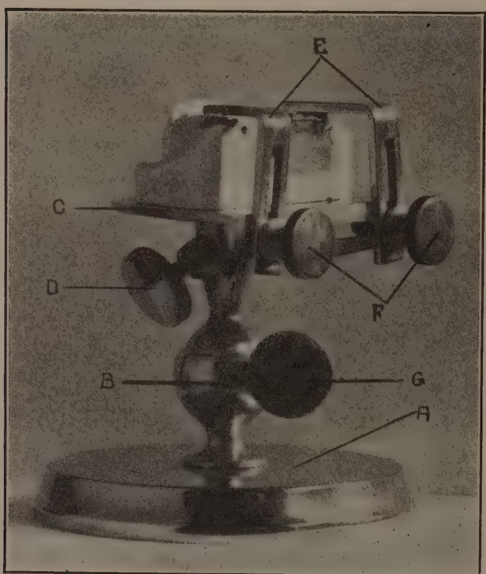


FIG. 1078.—The Bach soldering stand.

casts, the latter being clamped tightly upon a movable base, capable of being turned in any position by a swivel joint at the base of the stand.

Soldering Technique of the "Junior Pin and Tube" Arch.—The constructive technique of the "pin and tube" arch, represented in the "junior pin and tube" appliance, a modification of the Angle sectional pin and tube arch, requires more delicacy of manipulation, especially in soldering, than the assembling of the parts for use with the plain alignment arch and its anchor bands and auxiliary lingual wires, etc. Hand soldering, is still effective for the uniting of the parts of the "pin and tube" appliance, although there have been devised methods whereby the smaller and more delicate parts to be united, such as the vertical tubes to the plain bands and the upright locking pins to the arch, are held in a specially constructed jig or an automatic clamp of special design.

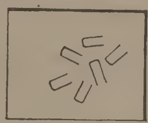


FIG. 1079.—Staple solder.

Dr. Angle's method of soldering the vertical tube to the plain incisor or cuspid band is to place a staple of solder, Fig. 1079 (18k for gold and platinum and 24k gold for iridio-platinum bands) upon the mark on the labial surface of the band, lay the tube upon it, and hold the band in the flame of the blowpipe with a solder tweezer until the staple fuses.

Another method, suggested by the author, is to use an automatic clamp, Fig. 1080, for holding the vertical tube in position in addition to the

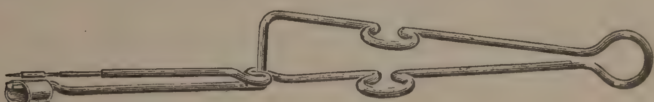


FIG. 1080.—Clamp for holding vertical tubes in position while soldering.

staple solder. The upper arm of the clamp has inserted into it a short section of stub steel wire, tapered at one end to receive and tightly hold the vertical tube so that it cannot be lost or displaced during soldering.

A still more delicate soldering operation is that of soldering the pins to the arch at the indicated points and at the proper angles of inclination for each tooth. The hand soldering technique described by Dr. Angle consists in the use of a pin holder (Fig. 1081) which is held in one hand and the arch wire supported in the other by a pin vise which will be found of assistance in holding the arch wire firmly.

Owing to the difficulty of placing a piece of solder between the pin and the arch, the use of solder rings has displaced other methods of manipulation. One of these rings, Fig. 1082, is sprung on the fish-tail end of the

pin, the head end being in the pin-holder, and the pin and arch wire held in approximation, the pin at the properly judged angle of inclination to perfectly fit the tube, and the solder fused into place. The soldering

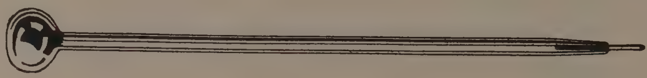


FIG. 1081.—Pin vise for holding vertical pins while soldering.

pliers, devised by Dr. C. A. Hawley, Fig. 1083, are very convenient for holding the smaller gauge arch wires while the pin is soldered in position.

FIG. 1082.—Solder rings.

Annealing and Tempering the Arch Wires.—The arch wires for the labial or buccal arches should be annealed and plunged into cold water

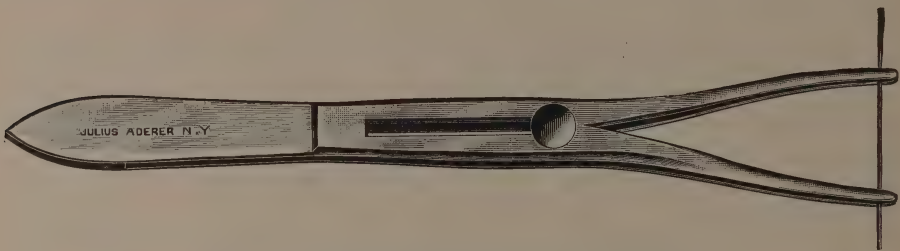


FIG. 1083.—Soldering pliers designed by Dr. Hawley.

before bending, using an annealer such as is illustrated in Fig. 1084, also an invention of Dr. C. A. Hawley, or one of the more complicated electric annealers.

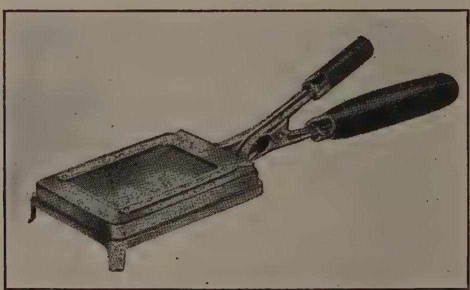


FIG. 1084.—C. A. Hawley annealing device.

After the arch has been fitted to its final position and all attachments uch as auxiliary springs and hooks added, it should be heated to a cherry

red in the annealer and cooled slowly in the air, thus giving it a uniform temper. Some operators prefer, however, to anneal the arch wire and auxiliary springs before attachment, and obtaining the requisite temper of auxiliary springs by bending them into position.

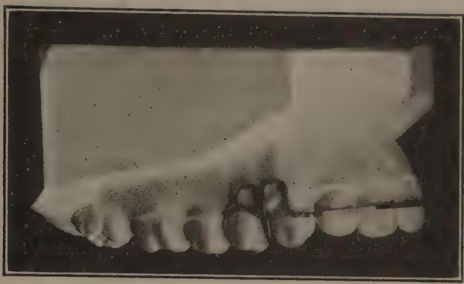


FIG. 1085.—Labial construction of Hawley removable retainer.

Construction of the Hawley Removable Retainer.—The Hawley retainer is made upon a plaster cast of the teeth or upon an artificial stone cast. The 19 gauge clasp gold wire or Ney's E wire used for the labial loops is started from the lingual surface of the cast, bent over the occlusal

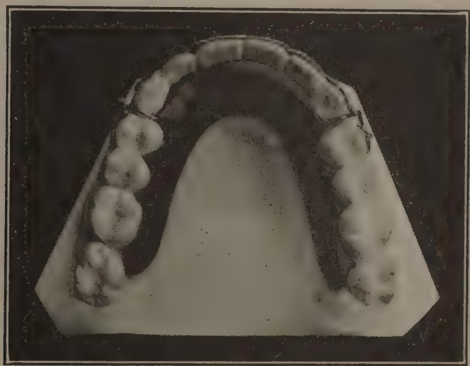


FIG. 1086.—Lingual construction of Hawley removable retainer.

surface of the cast in the embrasure between the cuspid and first bicuspid, following closely the line between these two teeth until the loop is made ending on the labial surface of the cuspid. The section of flat or ribbon arch wire, .022 inch × .036 inch, of the quality of Ney's E wire, fitting in between the ends of the labial loops, follows the contour of the labial surface of the incisors and is soldered to the ends of the loops with 18k solder. Extending distally from the loops on either side are convex bicuspid clasps of 19 gauge E wire soldered to the loops either directly at the gum line or made in the form of an extension arm from the top of the loops as shown in Fig. 1085. No tension should be exerted by the

clasps at the surfaces of the bicuspids above the points of greatest contour by the clasps.

A thin wax portion is next made with the curved ends of the wire framework imbedded therein, and the vulcanite portion constructed therefrom, Fig. 1086, using a strong and elastic rubber, vulcanized between two sheets of No. 60 tin foil. The use of a rugæ pack to reproduce the natural

FIG. 1087.—Banded incisors with parallel tubes for pin and tube arch.

rugæ of the mouth adds materially to the comfort of the plate. The edges of the retainer coming in contact with the lingual surfaces of the bicuspids should be thin so as to spring over their convex lingual surfaces to better hold the retainer in position.

Banding the Teeth in the Use of the Pin and Tube Arch in Permanent Dentures.—The use of the pin and tube arch requires the careful banding

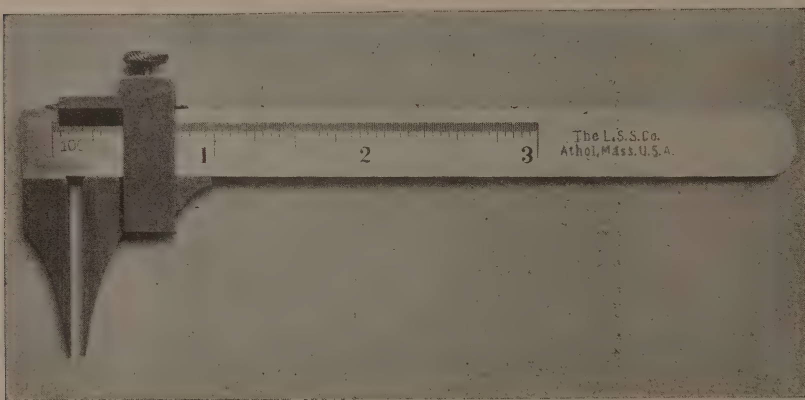


FIG. 1088.—Calipers used to parallel vertical tubes for pin and tube arch.

of every one of the anterior teeth requiring bodily movement. The band material should be made of iridio-platinum or gold and platinum, .003 inch in thickness, and of an average width of .19 inch. Fig. 1087 shows the proper position of the bands on the teeth, the pinched joint being made on the lingual side, and the bands festooned and fitted just under the gingivæ. The roughening of the surface of the band material with a flat file secures a better attachment of the cement so that the bands will not be accidentally loosened.

The tubes are paralleled vertically with the calipers shown in Fig. 1088 and aligned horizontally before soldering so that there is space enough on the incisal edge of the bands for the arch wire.

Construction of the Latch Locks on Pin and Tube Arch.—A piece of half round rod is soldered near one end of a six inch piece of .030 inch arch wire and a vertical loop formed anterior to the position of the vertical rod as shown at A, Fig. 1089. A round ball is fused on the end of the arch wire distal to the half round rod, and when the arch is completed, these ends are bent in a curve upon themselves until the round ball is directly over the top of the half round rod as shown at B, Fig. 1089.

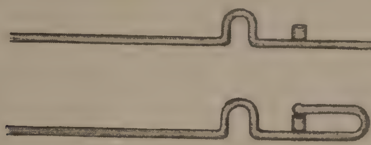


FIG. 1089.—Construction of the latch lock.

Adjusting the Arch Wire and Pins.—Beginning at one side of the dental arch, preferably the left, the half round rod of the latch lock on the arch wire is fitted into the half round tube on the molar band, a loop provided for anterior to this, as described, and the wire bent to conform to the tooth

FIG. 1090.—Construction of the pin and tube arch. (*After Dr. J. Lowe Young.*)

surfaces and embrasures up to the mesial angle of the first tooth to be attached with the pin and tube. A fine mark is made on the arch wire opposite the center of the bore of the tube on this band, the pin being attached at this point at the proper angle of inclination. The arch wire is conformed to the surface of the next tooth, marked, and the next pin attached, and so on, until all the pins have been attached and the arch fitted in place as in Fig. 1090.

The arch wire has a loop formed anterior to the latch lock corresponding to the loop on the opposite side, and a half round rod attached so as to just telescope in position in the half round tube on the molar band.

The end of the arch wire should be bent upon itself to form the latch lock over the half round tube when the arch is completed. The finished arch should be annealed to a cherry red and cooled in air, polished and inserted passively in its position with the pins locking in the tubes until the next

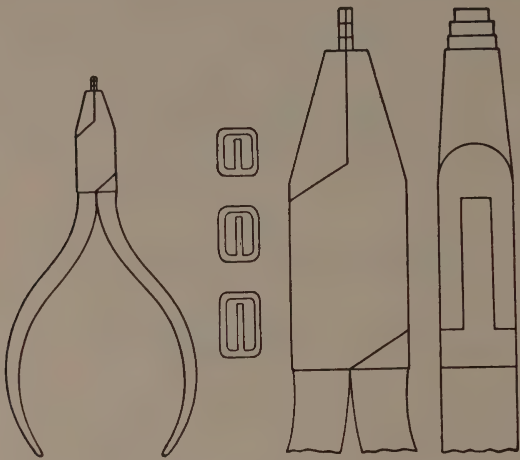


FIG. 1091.—Lockpins for pin and tube arch. (*Butler.*)

sitting. If the bends in the delicate pins should have straightened out by the frequent insertion in the tubes during the fitting process, the pins should be re-bent to their original shape before tempering so that they will lock in the labial tubes.

Auxiliary Lock Pins.—A stronger form of pin, to be used where there is a very great strain, has been devised by Dr. E. S. Butler. It is in the form of a latchpin as shown in Fig. 1091. This form of pin may be used on the molar anchor band when intermaxillary anchorage is to be used, or on the cuspid bands in development of the deciduous arch, or on any other of the arch where unusual strain is to be exerted. These pins are made with pliers, by winding .22-inch gold and platinum wire around the beaks of a pair of pliers with the ends fashioned as in Fig. 1092, in steps, which are of different lengths for several lengths of tubes.

CHAPTER LXV

ORTHODONTIC IMPRESSIONS AND CASTS

Terminology.—The terms *impressions* and *casts* are in general use in dentistry as well as in orthodontia, but in dentistry they refer more often to the edentulous mouth. Inasmuch as the use of these terms in orthodontia is in connection with the full or partial complement of teeth in the dental arches it is essential that they be defined in respect to their use in orthodontia as follows:

An **impression** *of the teeth and dental arches is the reproduction of their imprint in some plastic material which will retain its form.*

A **cast** *of the teeth and dental arches is their reproduction through pouring or filling of the impression with plaster of Paris or some other plastic material which hardens on crystallization.*

FIG. 1092.—Finished casts in occlusion should exhibit an index number only on the front of the base and back of the capital.

From these definitions it will be seen that the *impression* is first made in order that the *cast* or reproduction of the teeth and dental arches, usually in plaster of Paris, may be finally obtained.

In orthodontia it is necessary for purposes of diagnosis and study to make casts of each dental arch and occlude them, as in Fig. 1092, in the natural occlusion of the individual in order to accurately reproduce a malocclusion or one that has been corrected.

Perfect Reproduction of Anatomical Form in the Cast.—The casts of each dental arch should separately exhibit to a minute degree all the fine lines of the anatomical structures which it is intended they should copy, such as the rugæ and stipples of the gums, the form and attachment of the frenum labium, the extreme height of the vault of the palate, the height of the labial and buccal portions of the dental arch well up to the line of demarcation of the gum tissue and the muscles of the lips and cheeks; especially should they show the perfection or imperfection of every tooth surface, including inclined planes and developmental grooves, and the facets of the cusps, which latter, to the experienced eye, tell a story which can be learned in no other way of the excursions of the mandible in mastication and the degree of use of the individual teeth.

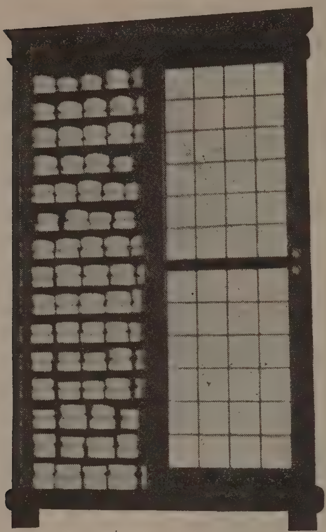


FIG. 1093.—Orthodontic model cabinet.

Such pathological conditions as abscesses, fistulas, hypertrophy and recession of the gingivæ, the ravages of pyorrhea, etc., should also be perfectly represented in these casts in order that their recognition may be given due consideration at the beginning of treatment of a malocclusion.

Diagnostic Value of Plaster Casts of the Teeth.—Accurate reproductions of the teeth and dental arches in the form of occluded plaster casts establish a most valuable record for diagnosis of existing malocclusion and maldevelopment of the dental arches, and are, therefore, necessary for the proper consideration of the possibilities of orthodontic treatment. Measurements made from these casts, and compared with measurements in the mouth from time to time, exhibit the progress of development of the dental arches which cannot be as accurately obtained in any other way.

From these casts a preliminary study of the case in hand in all of its different aspects may be made, and a definite plan of treatment decided upon with a full knowledge of every variation from the normal occlusal relations, as *e.g.*, the curve of the occlusal plane, the depth of the overbite, the width of the dental arches, their symmetry or asymmetry, the malocclusions of the individual teeth, neutroclusion, mesial or distal relations of the dental arches, etc.

These plaster casts also serve as guides to arch predetermination and indicate the proper position of retaining appliances upon the completion of treatment.

Esthetic Plaster Casts.—As a work of art the plaster cast of each dental arch in occlusion, trimmed to symmetrical lines with painstaking care, has a value in orthodontia in direct proportion to the skill which has been used in its production, and in a sense, reflects the skill of the operator in the various other mechanical techniques in use in orthodontia. The student who has been trained in the esthetic reproduction of the dental arches in the form of artistically trimmed casts will usually apply the same care in his operative work at the chair that he exhibits in the technique of making these plaster casts.

Plaster Casts as a Library of Reference.—While finely made plaster casts of the teeth are especially useful in diagnosis, prognosis, and treatment of the individual case, their collection in cabinets as in Fig. 1093, serves as a library for future reference and study, not only for the individual collector, but for future students who may have the privilege of studying them. The dental sections of the British museum and of our own national medical museum have a large number of plaster casts of the teeth and jaws on exhibition showing many varieties of malocclusion and malformation.

Legal Status of Plaster Cast.—From a medico-legal aspect, the plaster reproduction of the teeth is accepted as an accurate record of results accomplished, thereby insuring some protection to the operator from the occasional inappreciative and dishonest patient who resort to questionable methods to avoid paying their just obligations.

THE IMPRESSION

Impressions of the teeth from which accurate and artistic casts are produced are obtained only by the use of a quickly hardened, inoffensive, and non-injurious impression material which will retain its form on removal from the mouth, with the least amount of expansion and contraction, at the same time copying most perfectly the finest surface markings of the teeth and gums.

Classification of Impression Materials.—The materials used for taking impressions of the teeth and dental arches in orthodontia are divided into two classes:

1. Materials made plastic with water which harden by crystallization. *Plaster of Paris* is the chief material of this class, and is the base of other compounds made plastic and hardening in the same manner.

2. Those substances made pliable by heat which harden on cooling. *Modelling compound* is the best material of this class for orthodontic purposes.

Plaster of Paris has long been recognized as a nearly ideal material for orthodontic impressions, modelling compound not being capable of reproducing as fine surface lines as plaster, although very fine casts of the teeth may be produced from compound impressions by careful attention to the detail of the technique. These materials will be more fully described in the text.

Technique of Impression Taking.—First to be considered in the technique of impression taking is the *impression tray*, which is a metal receptacle for the impression material for its easy insertion into the mouth.

FIG. 1094.—Angle impression trays.

Angle Impression Trays.—The Angle impression trays, Fig. 1094, are especially adapted for taking full impressions of either arch, the flanges being high so as to bring the impression material high up on the gum surfaces labially and bucally, and the tray surfaces so shaped (without undercuts) and polished that they are easily removed from the partially set plaster impression in the mouth, although this smoothness is not necessarily a desirable quality in taking wax or compound impressions. These trays are graded in size in both upper and lower patterns, so as to fit the smallest as well as the largest dental arches, from No. 23½ to 21 in the upper tray sizes, and from No. 27 to 24 in the lower.

Selection of Impression Tray.—The size of the tray should be selected according to the size of the dental arch, large enough to leave a space of about one-eighth of an inch between the buccal surfaces of the teeth and the flanges of the tray, long enough in the upper arch to reach beyond the maxillary tuberosity, and in the lower to extend distally beyond the last erupted tooth in the dental arch. These Brittannia metal trays will admit of slight bending for special cases, and are therefore much more adaptable than trays made of nickel silver, aluminum, or other less yielding metals. When a tray becomes scratched or marred so that it is not easily removed from the impression, it should be discarded and a new one substituted in the set.

Preparation of Patient for Taking Impression.—It is necessary to observe certain preliminary steps in preparation of the patient prior to

taking an impression of the mouth, especially in the use of plaster. The patient should be comfortably seated in an upright position in the dental chair at the proper height for ease and convenience in operating, and provided with a towel or an apron with a pocket for catching surplus pieces of plaster.

Mental Control of Patient.—If a child is the patient and shows signs of being afraid of the operation, it should be made to feel perfectly at ease by spending a little time in describing the simplicity and frequency of impression taking, and in assuring it that it will not be hurt, in order to gain its confidence and thereby dispel its fears. Its attention should be diverted by conversation to other channels and not allowed to concentrate for more than a moment at a time upon the possibility of discomfort.

During the process of gaining the mental control of the patient an examination of the mouth may be made for lesions of any kind which might interfere with the comfort of the patient, such as canker sores, abscessed or tender teeth, caries, etc. thereby gaining the further confidence of the child through its becoming used to these preliminaries.

The presence of supernumerary teeth, protruded cuspids, or other teeth, and the location of spaces left by extraction of teeth, may be likewise noted at the same time, and the plan outlined for taking the impression with these factors in mind.

Prophylactic Steps before Taking Impressions.—The teeth should be thoroughly cleaned before taking an impression by the removal of all hard and soft deposits such as salivary and serumal calculi, etc., which would otherwise be reproduced upon the finished surfaces of the plaster casts. By first bathing lightly the surfaces with iodin or a plaque staining solution, the gelatinous plaques upon the teeth may be stained, so that they may easily be discerned and removed with an orange wood point dipped into flour of pumice mixed with a weak pyrozone solution.

Supersensitive Palate and Nausea.—In some few cases in which the patient has a supersensitive palate, the taking of an impression, especially the upper, will cause gagging and retching, and sometimes nausea. A preliminary test for a supersensitive palate is the running of the finger lightly over the back of the palate, and if the patient gags, unusual care must be taken not to get the impression material too far back upon the palate when taking the impression as these cases usually develop nausea from the violent retching. If these symptoms occur as soon as the impression is placed in the mouth, the patient should be directed to breathe hard, and hold the tongue down quietly, when the retching may subside, but if it does not, the impression, if of modelling compound, should be quickly removed from the mouth. A greater effort should be made to

control the retching when plaster is used, as attempted removal of the impression results in the disintegration of the plaster and considerable loss of time. It might be noted that there are some patients whose throats are so sensitive that it would be inadvisable to use other than the quickest removable impression material such as modelling compound.

Kingsley's Method of Taking Plaster Impressions.—In his work on oral deformities, Kingsley describes a method of taking plaster impressions of the mouth, fracturing and reassembling them, and constructing plaster casts from the filled impressions, the essential features of the process being followed at the present day.

Angle's Method.—Angle, in his technique teaching, introduced an improvement upon Kingsley's method of impression taking and model making which is so accurate that it forms the basis of the latest technique of impression taking and model making, although some of the details have been still further improved upon as will be noted. It consists in the exclusive use of plaster of Paris in specially formed trays, and in the hardening of the plaster and its removal from the teeth in sections, the fractured parts of the impression being fitted together later as a perfect impression, which is treated with separating varnishes and filled to form the cast, the shell of the impression being removed therefrom in sections after the cast has hardened.

Relative Positions of Patient and Operator.—In order that the greatest comfort for the patient and ease for the operator during the taking of an impression may be secured, certain simple directions as to the postures of both patient and operator should be observed. First, the patient should be placed in an upright position in the dental chair as this position tends to counteract the tendency of saliva and loose pieces of the impression material to gravitate backward down the throat, which always occurs when the patient's head and the chair incline backwards.

THE UPPER IMPRESSION

Positions for Upper Impressions.—In taking an upper impression the patient should be seated uprightly in the chair which is raised to the height at which the *patient's chin will be on a level with the elbow of the operator* standing at the right of and a little behind the patient.

Preliminary Trial of Tray in the Mouth.—Before placing the impression material in the tray it is advisable to adjust the tray in the mouth so as to be certain as to the proper size of the tray, and to learn the method of insertion of the tray in the mouth, as the aperture of the mouth is less than the width of the palatal end of the tray, requiring suitable manipulation for its insertion.

"Standing erect, at the right and a little behind the patient, the operator instructs the patient to open the mouth wide, when the tip of the index finger of the left hand is placed in the left angle of the mouth. The tray is grasped by its handle between the thumb and first two fingers of the right hand. The anterior portion of the right buccal flange of the tray is placed in the right angle of the mouth, and while distending the lips, the tray is swung into the oral cavity, as shown in Fig. 1095. The palatal border of the tray is carried upward over the tuberosities, at the same time the anterior portion of the tray should be depressed sufficiently to permit

FIG. 1095.—Preliminary trial of upper tray in the mouth.

a view of the relation of the palatal border of the tray with the tuberosities and vault."*

If there is sufficient space for a good body of impression material between the teeth and the flanges of the tray, the handle of the tray is elevated, and the teeth allowed to touch the floor of the tray, when the relations of the flanges of the tray with the labial and buccal muscles should be noted. The tray should rest in this position without discomfort before proceeding to the preparation of the impression material, the next step in the taking of the impression.

Plaster for Impressions and Casts.—There are two grades of plaster used in the technique of orthodontic impression taking and cast making, a very fine, quick setting plaster being used for impressions, and a fine but slower setting plaster for casts. French's impression plaster has long been in use among orthodontists for taking impressions, and its use by some operators for making casts, on account of its fineness and whiter appearance, is sometimes preferred. Kerr's snow white cast plaster has come into favor among many orthodontists because of its superior fineness, whiteness and hardness for both impressions and casts. Clover Leaf plaster has similar desirable qualities as an impression material.

Accelerating Agents in Setting of Plaster.—The impression plaster contains a certain quantity of a chemical ingredient, presumably potash,

* Dental Prosthetics by Dr. Geo. H. Wilson.

which causes it to thicken and harden very quickly, thereby shortening the length of time the impression has to remain in the mouth. It has therefore to be handled much more quickly than the cast plaster which need contain no medium for hastening its setting unless desired.

Mixing of the Impression Plaster.—A suitable quantity of the finest impression plaster should be sifted into a rubber bowl, one third full of water, preferably distilled, and of about 70° F. until the water is completely absorbed by the plaster, when after a brief stirring with a nickel silver bladed spatula, the plaster mix is ready for pouring into the tray. On account of the rapid setting of impression plaster, the addition of salt or potash for further hastening of this process is unnecessary and detrimental to the securing of a perfect impression because of the haste necessary in manipulation and the coarseness of crystallization of the plaster when these agents are used, being destructive of the fine lines on the surface of the impression.

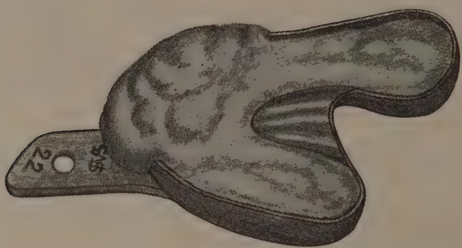


FIG. 1096.—Upper tray partially filled with plaster, palatal portion free, with slight excess of plaster on handle ready for taking upper impression without first filling labial and buccal spaces with plaster. (*After Angle.*)

Accurate Proportioning of Plaster and Water.—Either impression plaster or cast plaster, although varying somewhat in their fineness and setting qualities, will usually mix with water in the same proportion for use in making impressions or for making casts. It is desirable, however, that the quicker setting impression plaster be slightly thinner in consistency than the cast plaster as a rule.

The average proportions of plaster and water for an ordinary mix of either impressions or casts are in the ratio of two parts of plaster to one part of water. By using a glass measuring dish on which the number of ounces are marked the proportions will measure three ounces of plaster to one and one half ounces of water for either one impression or one cast. Doubling the quantity for two or three impressions to be filled is usually sufficient.

Mixing Plaster by Perfect Saturation.—Another method of mixing the impression plaster with water consists in placing the requisite amount

of plaster in a large plaster bowl, tipping the bowl at an angle while water is slowly added until the surface of the plaster is covered, then filling the upright bowl full of water. After the bubbles cease rising the water is poured off, and the plaster placed without stirring into the tray.

Distribution of Plaster in the Tray for Upper Impressions.—If the impression is to be taken of the upper arch, the anterior and lateral

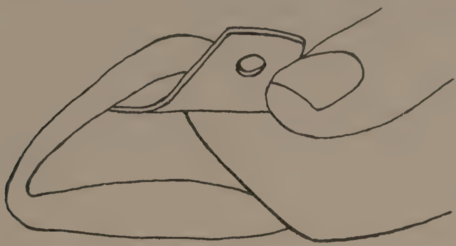


FIG. 1097.—Holding upper impression in place with index finger of left hand.

portions only of the tray are filled with plaster even with the rim, as in Fig. 1096, the vault portion of the tray not receiving any of the plaster as the excess from the anterior part of the tray will fill up the vault portion when the tray is forced into position. A small amount of plaster is allowed to rest on the front rim of the tray to force under the upper lip.

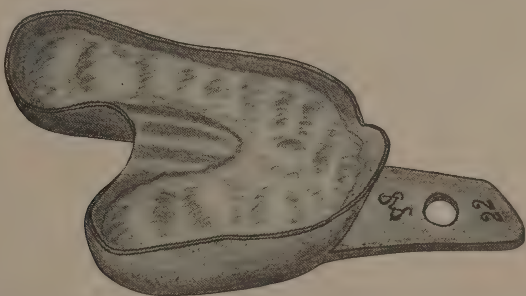


FIG. 1098.—Distribution of plaster in upper tray when labial and buccal spaces are first filled with plaster.

The tray being properly apportioned with plaster is next inserted in the mouth, and allowed to rest for a moment upon the occlusal edges of the lower teeth, while the upper lip is elevated, and the excess plaster, on the rim of the tray carried up underneath the lip with the finger or a spatula, the tray being then gently and evenly pressed into position until the surplus plaster is forced out beyond the palatal edge of the tray which is held in place with the index finger of the left hand as shown in Fig. 1097, until the plaster is set enough to support the weight of the tray. Care should

be taken that the tray is so aligned that an equal distance is preserved labially and buccally between the teeth and the sides of the tray.

Distribution of Plaster Partly in the Tray and Buccal Spaces.—A later and improved method of distribution of plaster partly in the tray and partly in the buccal spaces will secure an impression with higher sides and a better imprint of the muscles on the sides of the jaw than by the method just described.

In the following out of this improved technique, the tray is half filled with the impression plaster, as in Fig. 1098, none being placed in the vault portion nor on the front rim and handle of the tray as in the other method. Some of the plaster remaining in the bowl is then placed high up on the gums in the buccal spaces above the bicuspids and molars and under the upper lip, being carried to place by means of a narrow bone or agate spatula before the insertion of the tray, as shown in Fig. 1099. The partially filled

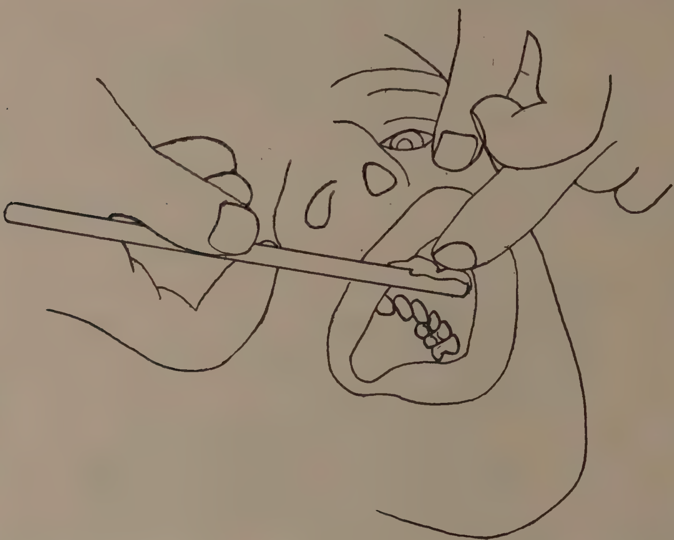


Fig. 1099.—Filling upper labial and buccal spaces with plaster before inserting impression tray partially filled with plaster.

tray should next be inserted in the mouth, and the plaster therein united with the plaster in the buccal and labial spaces by a gently exerted upward pressure.

The position of the operator should be at the right and in front of the patient until the tray, held by the right hand, is ready to be forced into place, when he should take a position partially in the rear of the chair, holding the tray with the index finger of the left hand. If any considerable excess of plaster should by chance be forced over the palatal edge of the tray towards the throat this excess should be immediately cleaned off

with an instrument designed for the purpose and of the form shown in Fig. 1100. The thin blade of this instrument is bent at an obtuse angle and conforms to the lower surface of the upper impression tray near its distal border.

FIG. 1100.—Instrument for removing excess plaster beyond palatal portion of upper tray.

Removal of Tray.—The surplus plaster is cleaned from the tray and the excess of saliva is removed with pledgets of cotton held in a pair of tweezers while the plaster is setting. All small pieces in the back of the mouth should be carefully removed, also, as they might cause the patient to gag or become nauseated. The impression is allowed to harden a few minutes after which the tray is quickly loosened from the impression by a

FIG. 1101.—Grooving upper impression over cuspid region after removal of tray.

slight upward or downward movement of the handle of the tray, and removed.

Grooving the Impression.—After removal of the surplus pieces of plaster with cotton pledgets, vertical grooves are next cut in the impression over the cuspid region, as in Fig. 1101, unless the cuspids are in labioversion, when the grooves are made mesial or distal to their positions according to the indications for easy removal of the section. After a little

practice, one groove only will be found sufficient. A properly shaped reversable knife for cutting these grooves in both upper and lower impressions is shown in Fig. 1102. These grooves should be cut in a V-shape about two-thirds through the impression, and not over one-eighth of an inch wide on the surface, thus, giving a leverage for the knife in fracturing the impression.

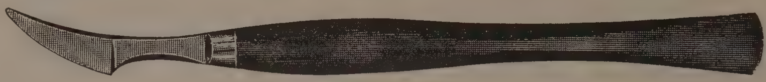


FIG. 1102.—Impression grooving knife.

Metal Inserts for Grooving Impressions.—A method of grooving the impression without the use of the knife has been described by Dr. E. H. Angle. It consists of the cutting of vertical slits in the impression tray directly over the cuspid region, and the insertion of flat pieces of metal into the slits in the tray and partially through the soft plaster immediately

FIG. 1103.—Metal inserts for grooving impression.

after the insertion of the plaster filled tray in the mouth. The metal inserts being removed when the plaster has set, leave narrow grooves in the plaster deep enough so that the impression is easily fractured along the line of the grooves. Here again, but one groove will be found necessary to fracture the impression as in the case of the knife cut groove.

The writer has found that by making up these metal inserts in nickel silver, and providing them with a soft solder backing on the edge exposed to the lips, as in Fig. 1103, the lips are protected from the sharp edge of the metal.

Removing the Impression.—If the plaster is sufficiently hard to fracture, as tested by breaking a small piece from the same mix in the

plaster bowl, the edge of the grooving knife is inserted in one of the grooves of the impression, and by a quick, prying motion away from the median

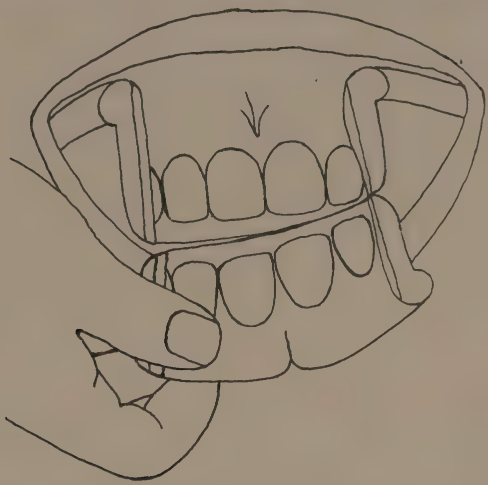


FIG. 1104.—Removing labial section of upper impression.

line the labial section is fractured and removed, as shown in Fig. 1104, the two buccal sections being next fractured and removed by exerting an

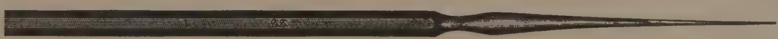


FIG. 1105.—Bluntly pointed instrument for prying loose vault section of upper impression.

outward pressure against the anterior fractured edges with the thumb of the right hand, holding the lips out of the way with the fore-fingers of

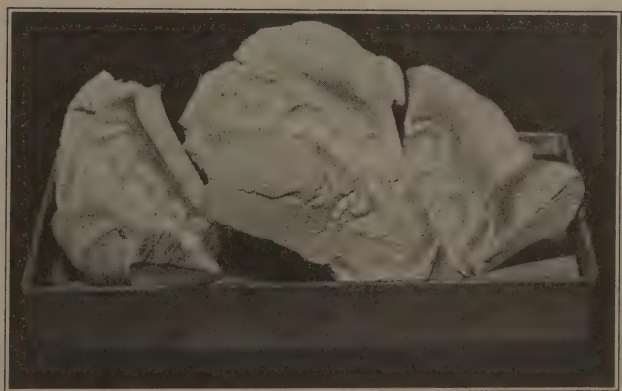


FIG. 1106.—Fractured pieces of impression placed in box for drying before assembling.

the left hand. Occasionally, when the malocclusion of the anterior teeth presents too many undercuts for the easy removal of the labial section,

the buccal pieces may be removed first. The vault section is then carefully loosened and pryed out with a bluntly pointed instrument with a heavy shaft similar to the one shown in Fig. 1105, the point being inserted carefully between the lingual surfaces of the teeth and the impression at several different places on both sides of the dental arch.

Often the upper impression may be removed in from two to four pieces, yet occasionally it will fracture into a dozen or more pieces. The appearance of the fractured portions of the impression after removal is usually as illustrated in Fig. 1106, the fractured edges being clean and sharp, and ready after drying, to join together with beads of wax. The pieces should be placed in a small box upon which the date and the name and age of the patient, to be later copied upon the posterior portion of the cast.

THE LOWER IMPRESSION

The Lower Impression.—The lower impression differs from the upper in only a few essential features, principally in the operating positions, the form of the tray, etc. Saliva will collect more abundantly than with the upper impression and it will be necessary to continually swab the surface of the impression in the mouth in order to get rid of the excess saliva. The saliva ejector will occasionally be found useful.

Relative Positions of Patient and Operator for Lower Impression.—In taking the lower impression, the position of the patient is slightly different from that taken for the upper impression. The patient is seated in an upright position with the chin as high as the shoulder of the operator, who stands in front of and facing the patient, where he may insert the lower tray with the greatest ease, and, at the same time, see clearly the entire field of operation.

Form of the Lower Impression Tray.—The lower imp ession tray, Fig. 1094, is U-shaped, the central portion being open so as to give room for the tongue, and the heels of the tray having no end retaining walls like the upper tray as they would press upon the gums distal to the last lower molar and cause discomfort as well as prevent the tray being forced down close enough to the teeth.

Selection and Trial of Lower Tray.—A lower tray, large enough to allow of one-eighth to one-fourth of an inch between the teeth and the flange of the tray, is selected, and is tried in the mouth by first distending the right angle of the mouth with the first finger of the left hand while the right side of the tray, held inverted with the thumb and first two fingers of the right hand, is pressed slightly against the left angle of the mouth, and then quickly inserted into position over the teeth, as in Fig. 1107, removing the finger from the right angle of the mouth.

Taking Lower Impression.—The lower impression may be taken with plaster in a similar manner to that of the first method of taking an impression with the upper tray, a slight excess being placed on the handle

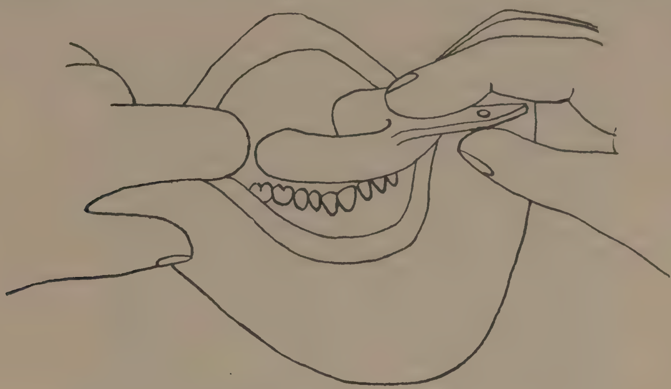


FIG. 1107.—Preliminary trial of lower impression tray.

as in Fig. 1108, or by the second method in which the labial and buccal spaces may be first filled with plaster before the partially filled tray, Fig. 1109, is placed in the mouth.

As the impression tray containing the plaster is carried into the mouth the patient is requested to raise the tip of the tongue while the tray is

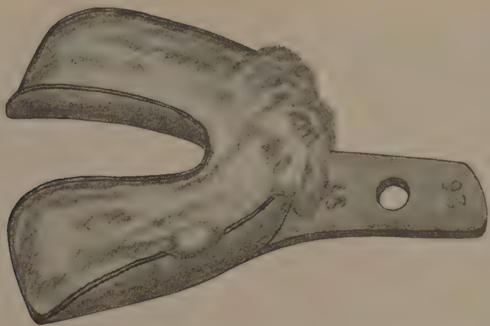


FIG. 1108.—Lower tray partially filled with plaster with slight excess on handle ready for taking lower impression without first filling labial and buccal spaces with plaster. (*After Angle.*)

inserted in the same manner as with the trial of the lower tray and pressed down upon the lower teeth, preserving the same alignment and relations of the teeth as in the upper impression. The inside folds of the cheeks are pressed away from the sides of the tray near its distal extremities, the excess plaster removed near the tongue, and the tray is then held with the first fingers of both hands, the thumbs being under the chin, and the operator standing in front of the patient until the plaster is sufficiently hard to hold the tray in place. Fig. 1109 illustrates the lower tray partially filled with

plaster ready to insert in the mouth according to the second method after the buccal spaces have been filled with plaster as shown in Fig. 1110. With the lower impression it is necessary to continually swab out the excess saliva with pledgets of cotton until the tray is removed, although, by pack-

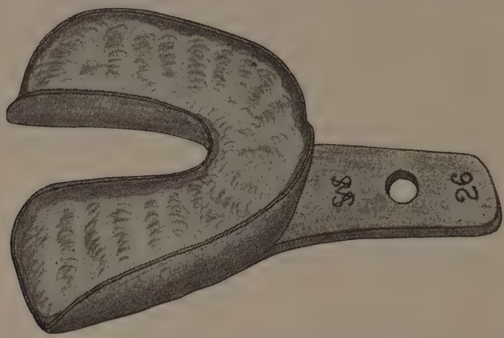


FIG. 1109.—Distribution of plaster in lower tray when lower labial and buccal spaces are first filled with plaster.

ing cotton in the buccal spaces over the parotid ducts, the flow of saliva may be temporarily checked.

Grooving Lower Impression.—Grooves are cut in the labial surface of the lower impression in the same relative positions as in the upper

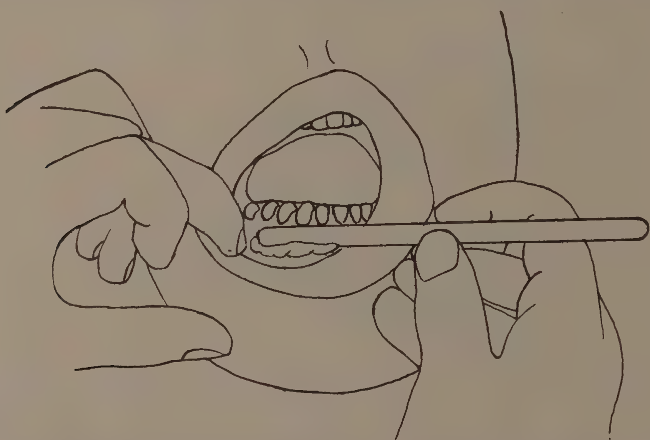


FIG. 1110.—Filling lower labial and buccal spaces with plaster before inserting lower impression tray partially filled with plaster.

impression, and the labial section removed in a similar manner. The lingual sections will often cling to the buccal sections and one half of the lower impression be removed intact, breaking lingually to the incisors, if a gentle upward pressure is exerted with the thumb upon each of the buccal sections in turn after removal of the labial section. If the buccal sections are fractured first, however, the lingual sections are loosened by a slight

lingual pressure on their topmost edges with the thumb and are easily removed.

Use of Cores Where Teeth are Missing.—When an impression is taken of a dental arch with one or more of the bicuspids or molars missing, it is

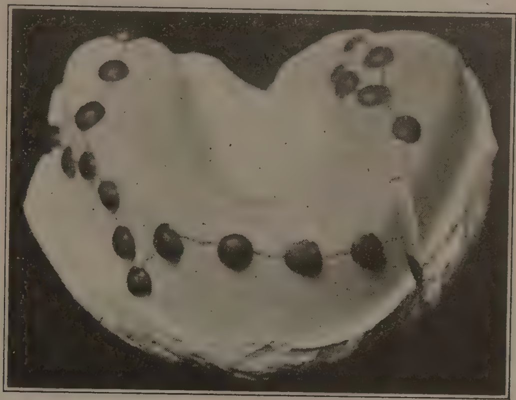


FIG. 1111.—Assembled upper impression, line of fracture beaded with hard sticky wax.

advantageous to place a core of modelling compound in the space of the missing teeth, replacing the core in the impression when the pieces are

FIG. 1112.—Palatal portion of upper impression after assembling.

being assembled. In this way the difficulties otherwise encountered in removing impressions from dental arches mutilated by extraction of teeth may be easily avoided.

A finger bowl filled with water and a small soft sponge for moistening and removing any hardened portions of plaster on the patient's face after taking the impression, are among the convenient articles necessary to the comfort and cleanliness of the operation.

ASSEMBLING IMPRESSIONS AND POURING CASTS

Drying and Assembling the Impressions.—The fractured pieces of the impressions should be dried over night usually, although they may be quickly dried in an electric oven if care is taken not to overheat the plaster. In assembling these pieces, after freeing their edges of granular debris, the smaller pieces should be united to the larger ones with hard sticky wax beaded upon the outside of the impression as in Fig. 1111.

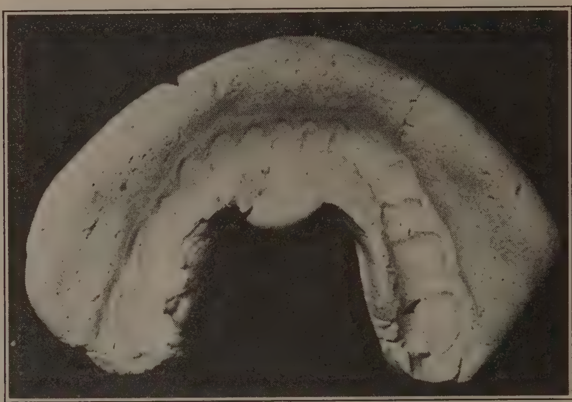


FIG. 1113.—Lower impression after assembling.

Replacing the fractured pieces in the tray for assembling is seldom successfully done, especially when the impression is broken into many small pieces as there is no way of cementing them together on the surface towards the dental tissues.

Figs. 1112 and 1113 represent very perfect upper and lower plaster impressions of the teeth after being assembled.

Application of Separating Mediums.—After being thus carefully assembled, each impression should be evenly coated with coloring and separating mediums, the fomer to produce a color line to show the nearness of the cast in shaving down the impression before removal, the latter to make a non-adhesive lining for the cast to be poured upon, so that it may easily be separated from the impression. A shellac solution forms the best color medium and serves to fill the pores of the plaster so as to prevent capillary attraction and too rapid withdrawal of the water from the newly

poured cast.* The impression should be dried slowly for half an hour, or rapidly in a compressed air box for three to five minutes, and then a thin sandarac solution applied and also dried, when the impressions are ready for marking of the occlusal plane and pouring.

Marking Occlusal Plane on Outside of Impression.—It is almost impossible to pour an impression, invert it on a glass slab, and expect to

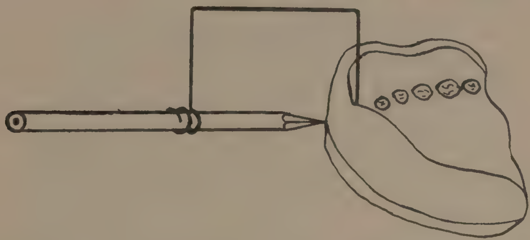


FIG. 1114.—Marking occlusal plane on outside of impression previous to pouring.

parallel the occlusal plane of the teeth with the horizontal plane of the slab unless the precaution is taken of marking the line of the occlusal plane on the outside of the impression.

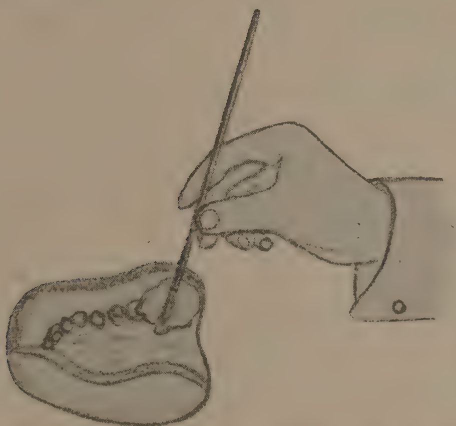


FIG. 1115.—Painting plaster of creamy consistency into tooth cusps before pouring balance of impression with plaster.

By using a simple parallelometer, as illustrated in Fig. 1114, an instrument suggested by Dr. W. E. Walker, the line of the bottom of the tooth cusps may be quickly traced on the outer surface of the impression. The instrument consists of a pencil inserted in a wire loop, the right angled extension of which ends in a point opposite the point of the pencil.

In use the wire point is placed successively into the bottom of the imprint of the incisors, the points of the cusps of the cuspids, and the

*According to Angle, these sloutions should be made up in the proportions of one ounce of shellac to three and one-third ounces of alcohol and one ounce of sandarac to two and one-half ounces of alcohol.

bottom of the buccal cusps of the bicuspids and molars, and a mark made with the pencil on the outer surface of the impression to correspond with the depth of these cusps, a line being drawn through all of the points on the outer surface of the impression, thus giving the line of the occlusal plane. The paralleling of a point on this line of similar tooth cusps on each side of the impression and one point in the central incisor region with the

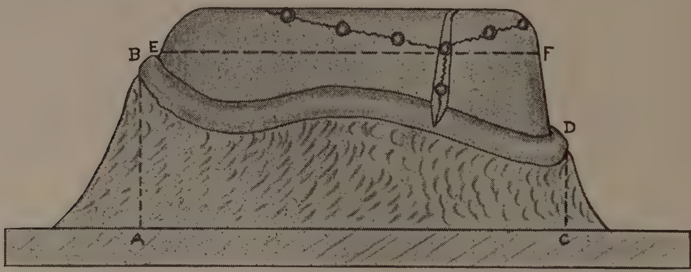


FIG. 1116.—Filled impression inverted on glass slab showing vertical lines AB and DC marking lines for trimming away excess plaster.

plane of the glass slab when inverting the impression, will cause the occlusal plane of the cast to be in the horizontal plane, at least in part, as will be presently described.

Pouring the Casts.—The impressions should be prepared for pouring by immersing them for a minute or two in water, which permeates the pores,

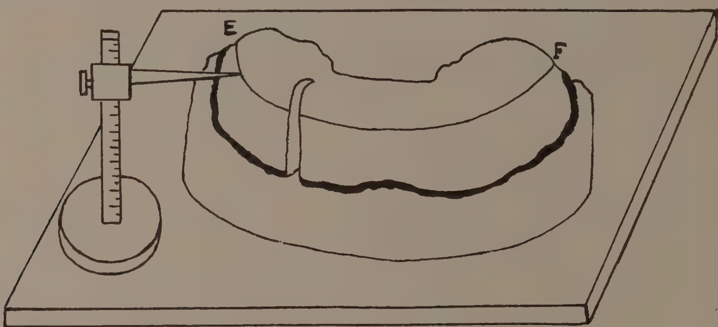


FIG. 1117.—Paralleling occlusal plane with surface of glass slab.

then removing the water from the cusps with a dry camel's hair brush, or blowing the water out of the tooth cusps with compressed air. A fine, white hard cast plaster, preferably Kerr's of Clover Leaf, should be mixed with water in a similar manner to the mixing of the plaster for the impression, and painted into the tooth cusps from one heel of the impression to the other with a fine camel's hair brush, as shown in Fig. 1115, until these cusps are evenly filled. The remainder of the impression is filled with plaster with a spatula, then a quantity of plaster is placed upon a glass slab and the filled impression inverted thereon as shown in Fig. 1116.

Paralleling Occlusal Plane with Surface of Glass Slab.—The distance of the anterior edge of the impression from the surface of the glass slab should be from one-fourth to one-half an inch, according to the size of the impression, and the line E F Fig. 1116 made with the pencil point held at right angles to the bottom of the tooth cusps and marking the occlusal plane should be parallel with the surface of the slab, measuring an equal distance of this line from the slab all around the impression with calipers, or an instrument similar to that shown in Fig. 1117.

Artificial Stone Casts.—The impressions may be filled with artificial stone instead of plaster, a cast being produced which is unbreakable, although very much more difficult to trim to the usual patterns than is the plaster cast. The directions for the use of artificial stone are given with the material.

Removing Excess Plaster from Periphery of Inverted Impression.—In order to save time in the trimming of the cast, the excess plaster beyond the side of the impression should be trimmed away before it is set, to perpendicular lines all around the impression as indicated by the lines AB and CD Fig. 1117. The plaster in the poured impression should then be allowed to set for at least a half hour before beginning the next step in the process of cast making. The plaster should be allowed to set for at least twenty minutes before removing the shell of the impression from the cast.

REMOVING IMPRESSION SHELL

Sectioning of Impression Shell.—The shell of the impression is more easily removed from the cast within an hour from the time of its filling as it then contains a greater amount of moisture than at any later time. Preparatory to the removal of the shell, the impression and cast should be immersed for a few seconds in water to slightly soften the surface. If there is a considerable amount of excess plaster extending beyond the edges of the impression, it may be roughly trimmed with the cast trimming machine

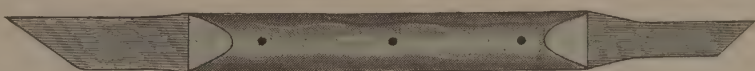


FIG. 1118.—Double bladed knife for sectioning impression shell. (*Design of Dr. A. P. Rogers.*)

shown in Fig. 1121. The beads of wax are next cut off, and the portion of the shell above the occlusal surfaces of the teeth shaved down with a knife, preferably of the form shown in Fig. 1118 until the color line of the shellac is plainly seen as illustrated in Fig. 1119.

The sides of the impression should next be grooved on the buccal and lingual surfaces vertically and horizontally from one heel to the other, as

also illustrated in Fig. 1119 using the large blade of the sectioning knife shown in Fig. 118.

The depth of the grooves should not be greater than the color line of the shellac varnish which becomes visible as the bottom of the groove is deepened toward the surface of the cast.

Removal of Sections of the Impression.—In removing the sections from the upper cast the right and left buccal pieces should be taken off first, leaving the labial section to support the incisors.

Occasionally, the lines of fracture of the impression, which extend above the occlusal surfaces of the teeth, will facilitate the removal of the buccal sections very materially, so that but little grooving in these regions is necessary, but the sectioning into smaller portions renders the teeth on

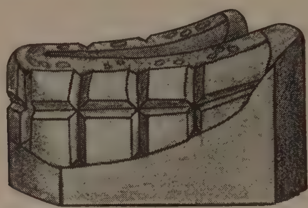


FIG. 1119.—Lower filled impression showing sectioning of impression shell before removal.

the cast less liable to fracture. After removing the buccal sections, the palatal, and then the labial sections are gently pryed off in a similar manner.

If the palatal section does not easily separate from the cast the palatal shell should be sectioned through the center, and each half tipped outward toward the center by inserting the edge of the knife under the heel of the impression.

The labial section, being already grooved, is next removed by an upward pry on small blocks covering the space of one or two teeth only. When the undercut is too great for prying upward on these sections, the knife should be inserted in the vertical groove and a section pryed off laterally. Care should be taken to remove the remaining labial portion by sectioning so as not to injure the delicate plaster reproduction of the frenum-labium, the sections on each side fracturing on the line of the frenum to advantage. The lower impression is grooved both buccally and lingually, and requires even more care in removing sections than the upper impression, especially in prying off the lingual blocks. When a block does not easily separate from the cast, it should always be resectioned, and smaller blocks removed one at a time. The

upper cast in the rough appears as in Fig. 1120 after the impression shell has been removed, when it is ready for trimming and surface finishing.

TRIMMING THE CASTS

After being moistened in water, the casts are next placed on the cast trimmer, Fig. 1121, with the occlusal surfaces of the teeth upward, and

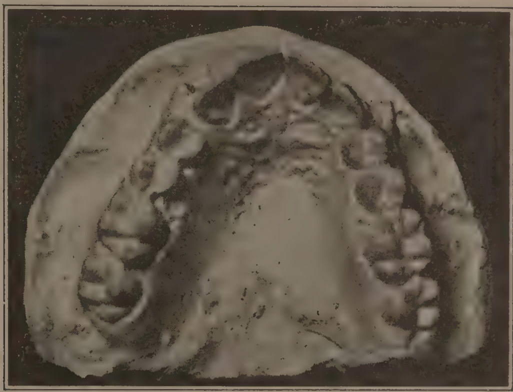


FIG. 1120.—Upper cast in the rough after removal of impression shell.

roughly trimmed to the geometrical outlines shown in Fig. 1122, these designs having been accepted as most artistic and conformative to the anatomical portions of each cast, the outer design for the upper cast differing from the inner in its having an obtuse angled front, affording an

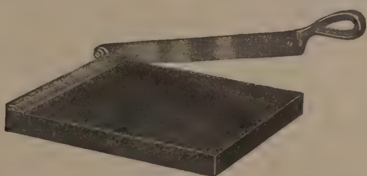


FIG. 1121.—Modified Eastman print trimmer for rough trimming of casts. (*Suggested by Dr. Varney Barnes.*)

extension for the frenum labium, the front of the lower cast being simply a curved plane.

From a geometrical standpoint, the two patterns represent the forms of two triangles with equiangular basal angles, clipped posteriorly at right angles to lines bisecting these angles, and the anterior obtuse angle in the cast cut from equilateral intersections with the lateral lines directly over the cuspids, the curve of the pattern for the lower cast extending from the points of similar intersection on the lower cast.

Rough Trimming of Casts.—While the casts may be trimmed to these patterns with a knife and plane, the rough trimming is much more easily

and quickly accomplished by means of a trimming machine, one of the simplest of which is illustrated in Fig. 1121, a modification suggested by Dr. Varney Barnes of a photo print trimming machine. For cutting plaster

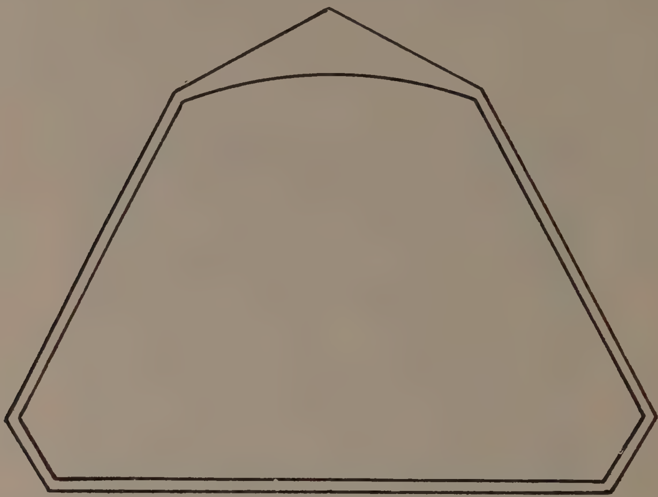


FIG. 1122.—Geometrical designs of top of upper cast (outside) and bottom of lower cast (inside), otherwise designated as capital and base of model respectively.

the removable blade must be highly beveled and sharpened, and the plaster casts moistened before trimming. Placing the casts with patterns outlined upon them upon the table of the machine with the occlusal surfaces

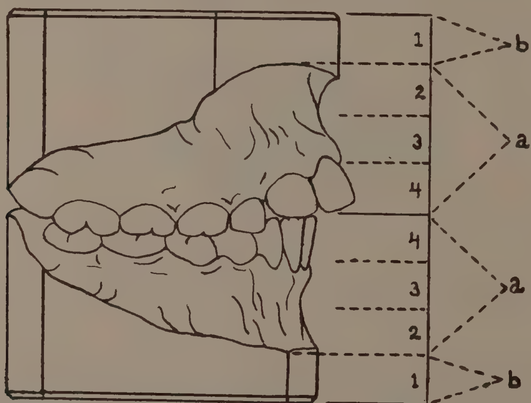


FIG. 1123.—Proportions of art (b) and anatomical (a) portions of casts measured as 1 to 3.

of the teeth upward, the lines of intersection are gradually approached with the lever knife, shaving off portions of the cast of a size which will leave a smooth surface and not a broken margin, which will happen if too large portions are cut off at a time.

Proportion of Art and Anatomical Portion of Casts.—A definite proportion between the height of the art and the anatomical portions of the casts which is most artistic and pleasing to the eye has been worked out by different orthodontists and is determined by making the height, b, of the art portion, equal one quarter of the anatomical portion, a, Fig. 1123, measuring these proportions on the labial sections of the art and anatomical portions of the casts, preferably from the corner of the curved anterior plane of the art portion of the base, and from the narrowest part of the art portion of the capital.

The proportionate relation of one quarter of the total height of the cast for the art portion and three quarters of the total height for the anatomical portion should be applied to all casts which have been made from labially deep impressions. On casts in which the labial portion is shallow, due to a shallow labial impression, it may be necessary to change the proportions to one-third of the total height for the art portion and two-thirds for the anatomical portion in order to obtain a well balanced model.

In the finished model of the casts in occlusion, the top and base should be parallel, and the posterior vertical planes of each cast in the same vertical plane, the latter defining the mesio-distal relation of the casts in occlusion. The further trimming to the patterns in Fig. 1122, and finer finishing of the various vertical and horizontal planes of the upper and lower casts must be done according to certain well defined measurements in order to preserve the symmetry and proportion of the occluded casts.

Formation of Arches within a Triangle.—The patterns shown in Fig. 1122 are both formed within an isosceles triangle the two long sides of which are parallel to the general line of occlusion of the bicuspids and molars on each side of the dental arch. The diverging lines of a triangle lend themselves most accurately to the diverging lines of the buccal surfaces of the teeth from the cuspids to the last molar.

Triangular Chart for Locating Sides and Base of Triangle of Dental Arch.—By the use of a triangular chart upon which the casts are superimposed, the sides and base of a triangle may be outlined upon the bottom of the casts, and the various angles and curves of the geometrical patterns drawn thereon in advance of the actual cutting or trimming of the rough portion of the casts to these patterns, as illustrated in Fig. 1124.

Dr. F. C. Rodgers devised a chart of this nature, using, however, but one triangle within which to include the casts, and, while this chart would be applicable to many cases, there are many others in which the degree of divergence of the line of the buccal surfaces of the bicuspids and molars varies considerably from the lines of divergence of the one triangle printed upon the Rodgers chart. This necessitates the use of two or more other

triangles in which to include such casts in order to obtain a triangle the sides of which will parallel the buccal surfaces of the bicuspids and molars.

The Author's Chart.—The author has arranged a chart with three triangles of varying lines of divergence from the apex to conform more nearly to the varying degrees of contraction of the anterior portion of the dental arches in malocclusion, as shown in Fig. 1125, the chart being well adapted for casts of deciduous as well as of permanent teeth.

In use the cast is placed upon the chart with the median line of the cast in register with the median line of the triangles, AE, as shown in Fig.

FIG. 1124.—Pattern drawn on bottom of base after outline of triangular pattern from chart shown in Fig. 1125.

1126 and moved forward from the base line 40 of the triangles until it is determined which one of the triangles most nearly parallels in its two long sides the buccal surfaces of the teeth from the cuspid to the last molar, when the bottom of the cast is marked with these lines of intersection, the pattern drawn upon it, and the cast accurately trimmed to the symmetrical pattern thus drawn.

Trimming the Casts to Patterns Outlined on Base and Capital.—The finer trimming of the casts to the patterns outlined on the base and capital may be done on one of several different machines, which vary considerably in design and ease and rapidity of execution.

The Northcroft Plane and Shooting Board.—One of the simplest of these machines, which is better suited for final finishing of the casts after rough trimming, is the shooting board and plane, shown in Fig. 1127, designed by Dr. G. Northcroft of London, Eng. With this machine, the sides of the casts may be quickly planed at right angles to the base. A raised platform allows the cast to be raised when planing the anterior planes thus avoiding damage to the incisors.

The Revolving Blade Trimming Machine.—The plaster casts may be quickly trimmed to follow the outlined patterns on the base and capital on a machine with two revolving blades, similar to the drawing in Fig. 1128.

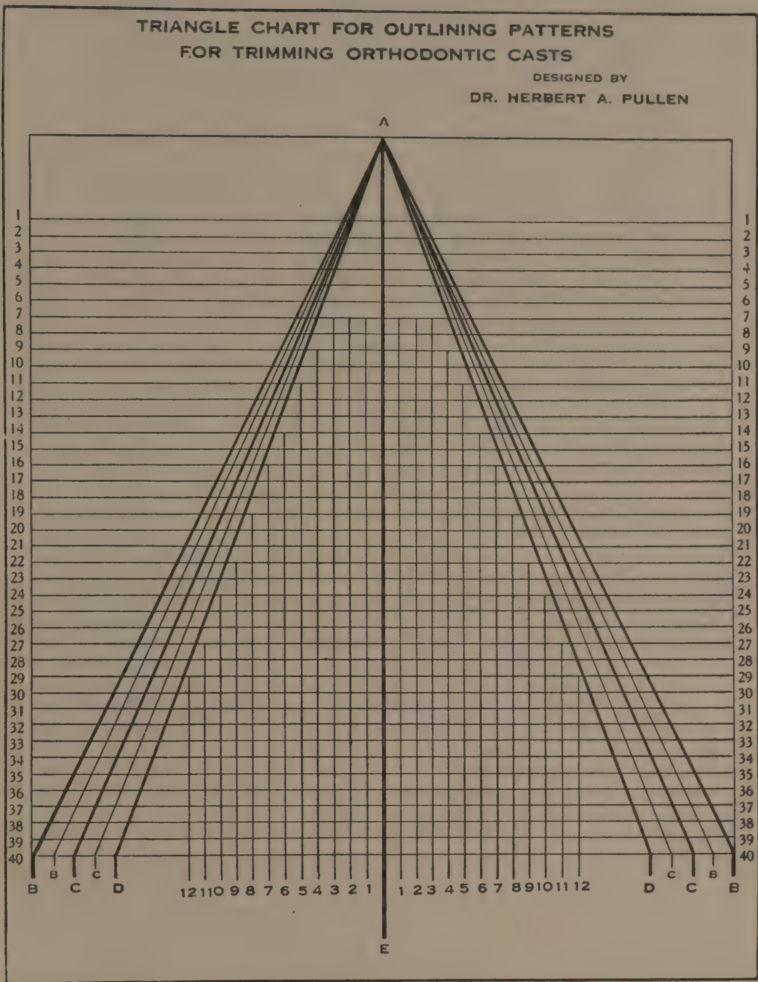


FIG. 1125.—Multiple triangle chart for outlining enclosing triangles on base and capital.

The finer finishing of the trimmed surfaces is better accomplished afterward on the Northcroft shooting board with the plane.

The Howard Model Trimming Machine.—The most ideal machine for the trimming as well as final finishing of the surfaces of the art portion of the casts is the machine illustrated in Fig. 1129, the result of several years of work on the part of Dr. Clinton Howard.

The machine consists of a revolving multiple spiral bladed cylinder enclosed in a metal box, fitted with safety devices to prevent accidents,

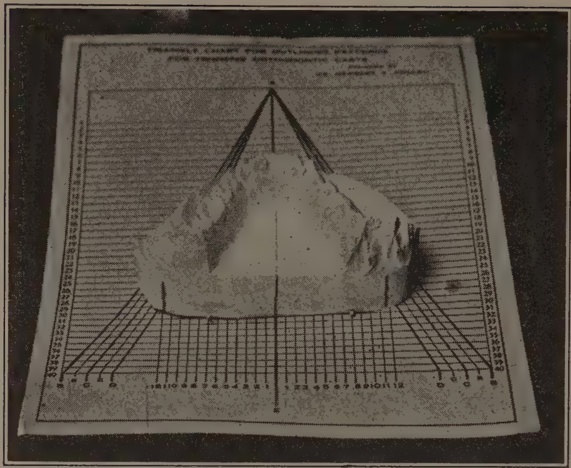


FIG. 1126.—Paralleling buccal surfaces of biscuspids and molars on cast with one of the triangles shown on chart, marking intersections on base.

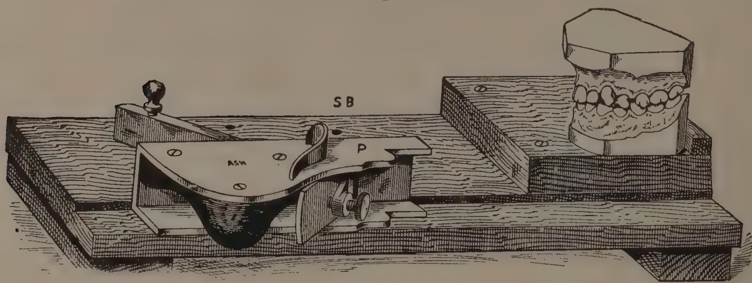


FIG. 1127.—The Northcroft shooting board and plane for trimming vertical planes of casts.

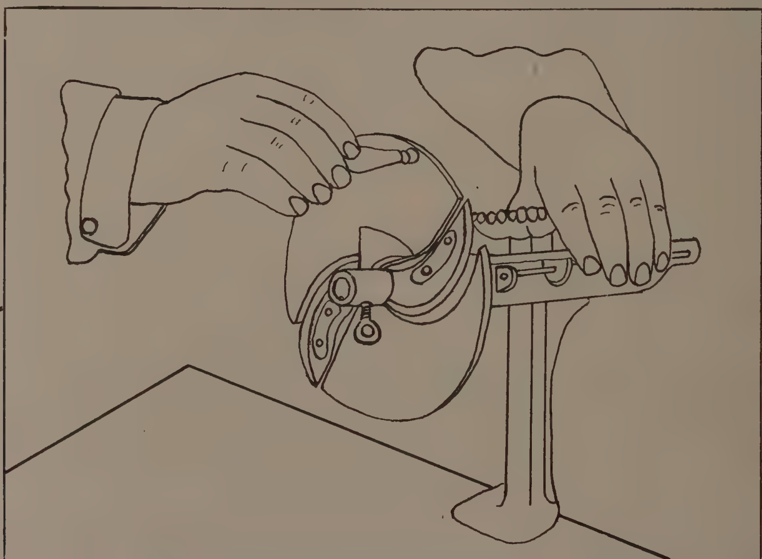


FIG. 1128.—Revolving blade cast trimming machine.

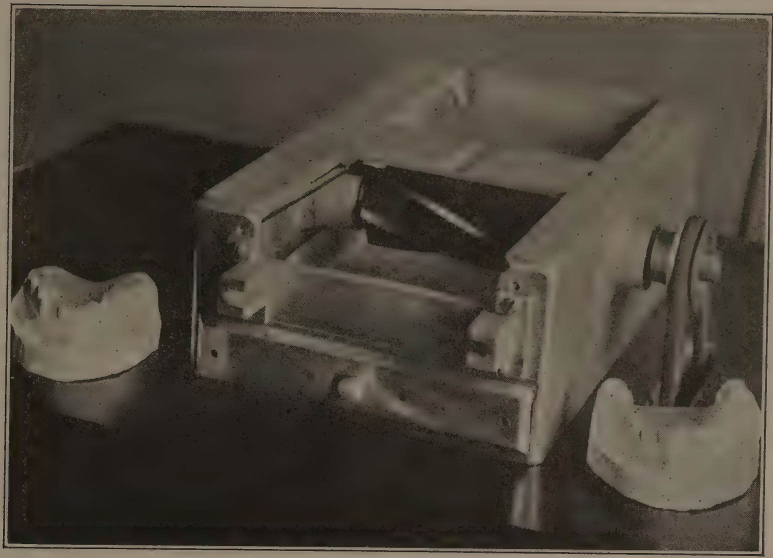


FIG. 1129.—The Howard motor driven cast trimming machine with revolving multiple spiral bladed cylinder.

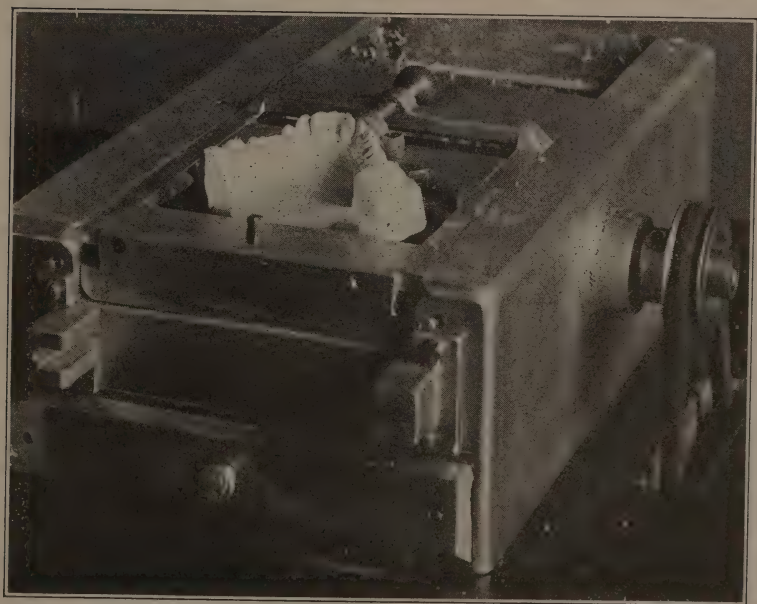


FIG. 1130.—Lower cast in model carriage ready to be moved over cutting blades in Howard machine.

the revolving cylinder being operated at a high speed by means of an electric motor.

The cutter is separate from its shaft, hence can be quickly changed when desired. Several blades can be kept on hand thereby assuring sharp cutting edges at all times. The cutter is geared to revolve 4311 times per minute thus cutting very rapidly.

In Fig. 1130 is shown a lower cast in the model carriage, which is pushed over the cutter with the thumb and index finger of each hand. A blade protector precedes the model carriage in its forward movement over the cutter, and recedes also with the backward movement of the carriage by means of coiled springs attached internally on each side.

A detachable device known as an upright clamp holds both upper and lower casts in occlusion in the model carriage so that the vertical planes of the base and capital of the model may be trimmed at the same time by passing the carriage slowly over the revolving cutter.

The machine is provided with special measuring instruments devised by Dr. Howard, and an original method of measuring the patterns for marking on the base and capital of the model is described in the pamphlet accompanying the machine.

The actual cutting process consumes about two minutes, the measuring about six, thus requiring the minimum amount of time in trimming the casts.

MODELING COMPOUND IMPRESSIONS

Uses of Modeling Compound in Orthodontia.—Modeling compound may be used in orthodontia as a material for taking impressions for obtaining either fairly accurate consultation models or the less perfect study models, many orthodontists prefering it only for the latter, since casts made from plaster impressions are more perfect reproductions of the fine lines of the surfaces of the teeth and gums than are those made from compound impressions. Compound impressions, as usually taken, however, often present imperfections of tooth forms and inaccurate surface lines due to faulty manipulation and careless technique, the results of which are too often ascribed to the impression material rather than to the lack of skill of the operator.

As an impression material modeling compound has always been relegated to a second place in orthodontia because of the superior casts obtained from plaster impressions, but the need of discrimination is necessary in the use of any material, and it is believed by the writer that there exists the necessity and expediency of the use of a less perfect impression material than plaster under certain of the prevailing conditions in orthodontic practice.

For example, children of from two to six years of age are frequently the patients of the orthodontist, and, while plaster impressions may be taken of children of these ages, more or less difficulty is encountered, the child often strenuously objecting to the unpleasant taste and sensation, and the length of time necessary for the plaster to remain in the mouth before removal.

On the other hand modeling compound presents less difficulty in manipulation, is not unpleasant to the taste, and is left in the mouth the minimum amount of time.

Further, the deciduous teeth being short and the dental arch small, there is very little malalignment of the teeth, which present no large embrasures or other severe undercuts or obstacles to the direct removal of an impression without dragging, or impairment.

Hence, modeling compound, if properly softened, inserted in, and removed from the mouth in the direction of the long axes of the teeth, being sufficiently cooled and hardened before removal, ought to produce a fairly accurate impression of the deciduous or mixed denture although not copying the finest lines of the surface, such as the stipples of the gums, and other minute surface markings. The permanent dental arch, with its deep embrasures and undercuts, requires a much greater attention to the details of a perfected impression technique to produce results which are satisfactory to the skilled orthodontist. However, certain of the simpler cases of adult malocclusions seem to warrant the use of a less perfect impression material than plaster where the patient's comfort can be considered, and compound readily answers the purpose in these simpler cases.

Furthermore, the saving of many hours of time in the office of the busy orthodontist through the shorter and less difficult technique required to produce a cast from a compound impression over the time necessary to produce a cast from a plaster impression ought to be given due consideration when time is at a premium, and the considerations of treatment are more important than the details of a plaster technique.

The technique of the plaster impression is too valuable, on account of its extreme accuracy in results, to discard, but it is possible to discriminate in its use, choosing plaster as an impression material for complex malocclusions of all patients and in any case where extreme accuracy of form and surface detail is required, and using modeling compound in the cases of children of a tender age, and in other cases where the extreme in accuracy or reproduction of surface lines is not required.

With this preliminary understanding of the possibilities of modeling compound in orthodontia, a study of its varieties, and methods of use

may interest the student, or the orthodontist heretofore indifferent to this material, in perfecting himself in the technique of its use.

Varieties of Modeling Compound.—There are two varieties of compound in use in orthodontia at the present time, the familiar red compound manufactured in varying thickness of plaques, and the white English compound.

The white English compound (composition unpublished) takes a better impression than the red compound, although the latter when specially manipulated by taking an impression in two sections, as described later in the technique suggested by Dr. James D. McCoy, produces a very fine impression.

Wet Heat Method of Softening Compound.—In following out the technique for impression taking with the red modeling compound several thin plaques of this material should be placed in water heated to between 120° and 130° F., when it will readily soften, especially if kneaded between the fingers. If overheated, compound becomes very sticky and unworkable, so that the use of an electric water heater, with a regulated thermostat which will keep the water at the prescribed temperature during the manipulation of the compound, is a very useful adjunct to the operating equipment.

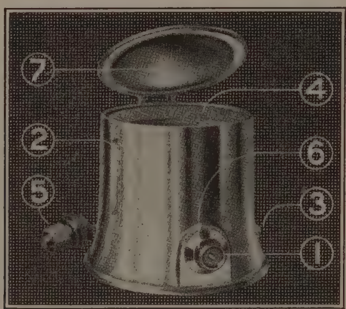


Fig. 1131.—The Monson electric thermostat for softening modelling compound.

The Electric Thermostat.—The Monson thermostat, Fig. 1131, recently placed on the market, is a very ingenuous device for the easy manipulation of modeling compound in the softening process. It is made of aluminum, and contains a cloth screen suspended in the water, holding the compound away from all metal surfaces during the heating process.

This electric thermostat automatically cuts down the current as shown by the dimming of a pilot light when the water reaches the desired temperature, which does not vary from that time as long as the current is turned on.

A movable dial adjusts the thermostat to the desired temperature and a thermometer neatly mounted in the side of the casing, acts as a check on the accuracy of the thermostat.

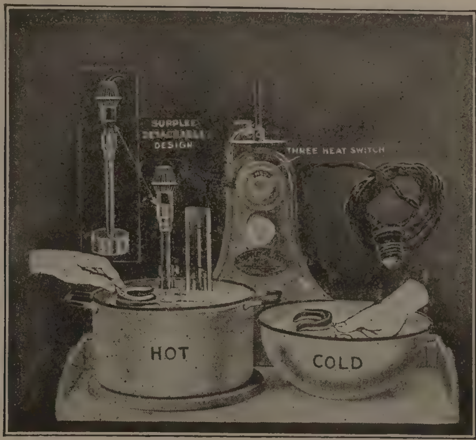


FIG. 1132.—Supple electric compound outfit (No. 2) with thermometer attached.

The Supplee Compound Heater.—By using a dish with a thermometer attached, as shown in the Supplee Compound Outfit in Fig. 1132, the temperature can be watched and regulated so as to prevent overheating of the

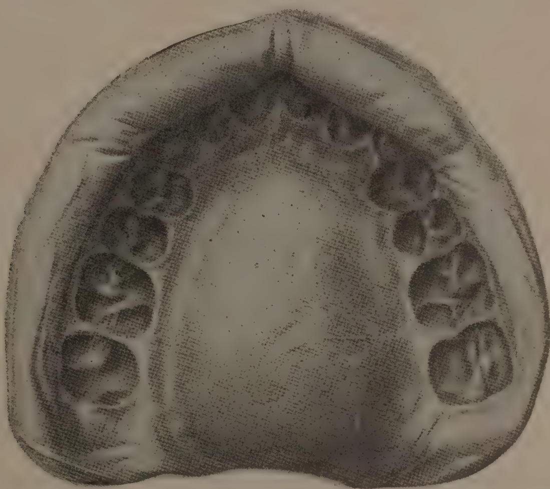


FIG. 1133.—Modeling compound impression of upper arch.

compound. An especially wound electric coil of three heats is encased and suspended one-eighth inch below the surface of the water so that it heats only the surface. When the switch is turned to "high" the heater

will boil within five minutes. When the switch indicates "low" it will retain the temperature indefinitely at about 160° on the surface providing the pan is filled within one inch of top. The bottom will remain between 135° and 140°. This is an advantage because compound will not deteriorate in 140° whereas it will in 160° or more.

The securing of uniform results in the heating of compound in this manner saves much time and is a valuable addition to the technique of impression taking with compound.

Manipulation of Compound.—On removal of the softened compound from the hot water, it should be kneaded and molded in the fingers to roughly approximate the inside of the tray and forced well down to the bottom of the tray which has been previously warmed so as not to chill the compound. In manipulating the compound in this way, all folds should be made in one direction and kept on the under side, so that the surface taking of the imprint of the teeth and gums may be smooth and conti uous. The compound should not be allowed to extend beyond the palatal heel of the tray in an upper, nor beyond the heel of the tray in the lower impression.

The compound is next depressed with the thumbs and fingers on the surface to receive the imprint of the teeth, raising a rounded roll towards the labial and buccal periphery of the tray to be forced underneath the lips and cheeks so as to get a deep impression. All of this manipulation of the compound should be done very quickly so as not to cool the material before taking the impression, and the surface should be further heated over a blue Bunsen flame to soften it still more and give it a surface gloss, when it should be immediately placed in the mouth and the impression taken.

If care is taken in the various steps of taking the impression there will be little if any dragging and a fairly sharp impression of the upper dental arch will be obtained, Fig. 1133.

As the ordinary technique of impression taking is familiar to the dental student or practitioner, attention will be called only to the bite impression and the labio-buccal impression for "study models," or casts, and describing somewhat in detail the sectional method of taking compound impressions as suggested by Dr. James McCoy.

The Bite Impression for Study Models.—A method of obtaining a study model showing the occlusion of the teeth at any one time may be described as the bite impression, the patient closing the teeth into a thick piece of softened compound which has been shaped into the form of the dental arch. The portion of the compound extending labially and buccally after the teeth are in occlusion is forced under the lip and into the buccal spaces with the fingers, and then, with the lips closed, the cheeks are manipulated in such a way as to exert pressure inwardly on the compound in order to get a good impression of the gingival borders of the teeth. This

method of taking a double impression is not as simple as it would appear from the description, and usually produces a distorted impression which requires more time to fill with plaster than if two separate impressions were made. Hence, it cannot be recommended.

Labio-buccal Impressions of the Teeth in Compound.—Occasionally, an impression in compound of the labial and buccal surfaces of the teeth only is desired, and may be obtained by placing a flat oval shaped piece of compound under the lips and in the buccal spaces of the mouth while the teeth are closed, quickly pressing the compound against the labial and

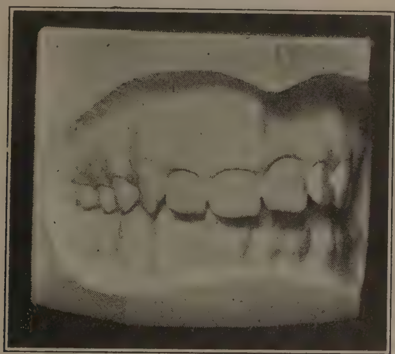


FIG. 1134.—Cast made from a labio-buccal impression in modeling compound.

buccal surfaces of the teeth while the lips are closed and manipulated so as to force the compound into the labial and buccal spaces.

On cooling the compound as in previous methods, it is removed intact and filled, the resulting cast appearing in Fig. 1134.

SECTIONAL IMPRESSIONS IN MODELING COMPOUND

Advantage of the Sectional Impression.—The advantage of taking a sectional impression in modeling compound over the usual method in which the impression is taken in one part in the ordinary way, resolves itself into the possibility of avoiding deep undercuts and consequent possible dragging of the compound in removal.

Division of Dental Arch in Respect to Undercuts.—For example, for the purposes of impression taking without dragging of the material in removal, the dental arch may be divided into two portions antero-posteriorly, the portion *posterior* to *the cuspids*, especially in children's mouths, presenting little if any deep undercuts, and the portion *anterior* to the *first bicuspids*, which exhibits the cuspid eminences and the deep hollows in the gum surface above the cuspid region and the forward inclination of the anterior teeth, all of which interfere with the removal of compound without dragging.

Following out the possibilities in overcoming the obstacles usually encountered in obtaining a perfect compound impression, Dr. James D. McCoy has suggested the following technique, which includes the use of specially formed trays for taking an impression in compound of the two divisions of the dental arch separately and later uniting them, thus avoiding the dragging of the material in the undercuts.

"The three most important factors of this technique (as described by Dr. McCoy) may be enumerated as follows:*

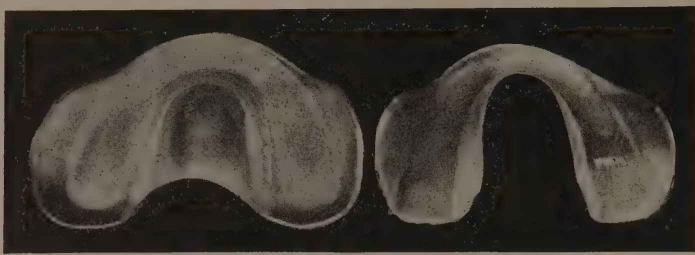


FIG. 1135.—Impression tray with sides similar to a plaster tray, but without a front or a handle. (*Dr. James McCoy.*)

1. The selection of a proper tray.
2. The proper preparation of the modelling compound.
3. Proper handling of the compound while in the act of making the impression."

Specially Formed Trays.—"The ordinary plaster impression tray is quite unsuited to modeling compound. The tray is an aluminium tray without a handle, with high sides, but with the front cut out, as shown in Fig. 1135. The amount of cut-out must be sufficiently great so that when the tray is placed in the mouth the sides will only extend forward to a point just posterior to the canine eminence. When placed in the mouth, such a tray will bring the modelling compound under pressure in contact with all portions of the dental arch except that portion which corresponds to the cut-out portion of the tray. This portion is ignored as the impression of it is obtained separately after that of the balance of the arch has been secured."

"As has been mentioned before, it is necessary to have a generous cut-out in the anterior portion of the tray. The absolute necessity of this will be shown later."

Softening the Compound.—"In heating the modeling compound care should be exercised. A water thermometer capable of registering at least 140° F. should be utilized. A glass or a porcelain dish capable of holding a quart of water serves as an easy means of immersing the compound

* Modelling Compound as an Impression Material for the Orthodontist. By James David McCoy M. S., D. D. S. (Int. Journal of Orthodontia and Oral Surgery, Aug., 1920).

which should be placed in the water with its temperature about 120°. This should be gradually raised either by means of an electric heater or simply by slowly adding hotter water until the temperature has been brought up to between 130° F. and 140° F. During the process of its heating the material should be kneaded between the fingers so that it may become uniformly softened. All of this requires but a very few minutes and can be carried out by the assistant."

Upper Sectional Impression.—"When the softened compound is ready to be placed in the tray the operator selects the proper amount for the upper tray, adapts it in and to the tray, and after a final immersion in the water, places the filled tray in position in the mouth."

"When the tray with its contents has been brought to its proper position it should be held firmly in place. It may then be chilled by cold blasts of compressed air or by use of cold water. Regardless of which

FIG. 1136.—The inaccurate portion is cut back to the point where the impression is good. (*Dr. James McCoy.*)

method is employed it is very important that it become well chilled before it is removed from the mouth."

Removal and Reinsertion of Palatal Section.—"After the preceding have been carried out a very accurate impression of the upper arch will be produced, with the exception of the portion lying between—and usually including—the canine teeth. Upon its removal this inaccurate portion of the impression is cut away to the point where the impression is good, a sharp line of demarkation being made as in Fig. 1136. The impression is then placed back in the mouth and made to occupy its natural position."

Separate Impression of Labial Section.—"While being held firmly with one of the fingers of the left hand pressed against the vault of the tray, a small portion of softened compound is adapted against the anterior portion of the arch, the lip being lifted for this purpose. This done, the

lip is allowed to come in contact with the material and should be gently pressed against it. This added portion of the impression is then thoroughly chilled and removed separately as shown in Fig. 1137. This is easily accomplished if the anterior portion of the impression has been properly cut back."

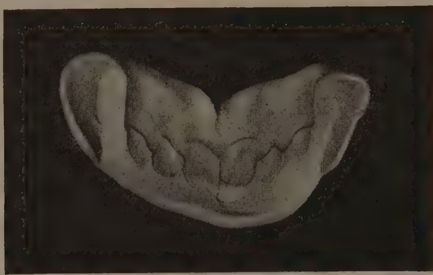


FIG. 1137.—The anterior portion of the impression is removed separately. (*Dr. James McCoy.*)

Assembling of Upper Sectional Impression.—"The larger portion of the impression is then removed from the mouth and the two sections fitted together. When their proper relationship has been established, the modelling compound should be fused at several points with a hot instrument so that the union may be permanent as illustrated in Fig. 1138."

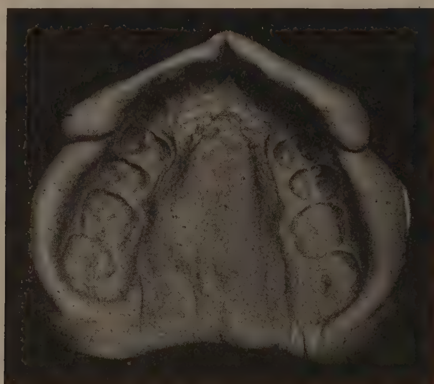


FIG. 1138.—The two portions of the impression are then united and the union made permanent. (*Dr. James McCoy.*)

Lower Sectional Impression.—"The same procedure is carried out in taking the impression of the lower arch. This is usually accomplished with less difficulty than is experienced in taking the upper, and for this reason the temptation often arises to take the impression all at one time rather than to resort to the sectional method. This will almost invariably

bring about inaccurate results which will be chiefly characterized by distorted impressions of the anterior teeth."

"Trays of ample size should always be used for both the upper and lower so that the sides of the impressions will have sufficient body to allow for properly trimmed model bases as shown in Figs. 1140 and 1142."

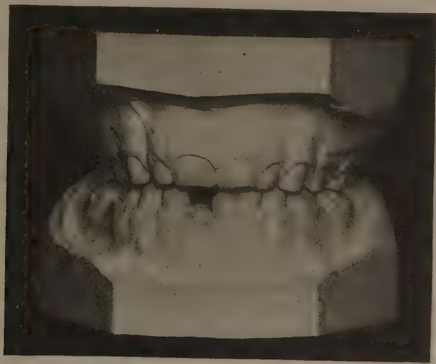


FIG. 1139.—Model of deciduous teeth from sectional compound impression. (*Dr. James McCoy.*)

Casts of the deciduous teeth in occlusion and from the occlusal view of each cast made from sectional compound impressions are shown in Figs. 1139 and 1140 respectively. Similarly made casts of the permanent teeth in occlusion and from the occlusal aspect are shown in Figs. 1141 and 1142.

The Multiple Sectional Impression.—"While impressions of the majority of cases may be obtained with the trays so far described there is

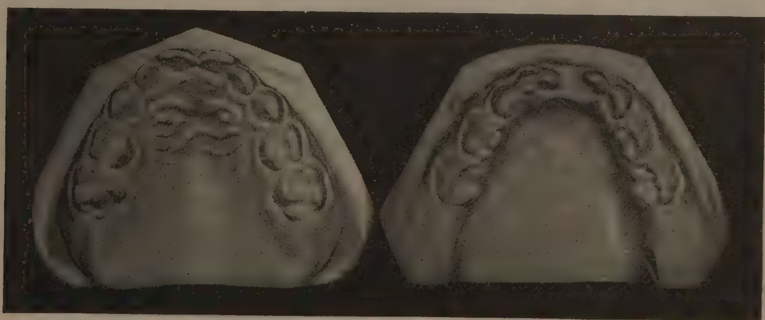


FIG. 1140.—Occlusal view of upper and lower casts shown in Fig. 1139. (*Dr. James McCoy.*)

always a possibility of cases presenting themselves in which a degree of deformity exists which will require that the impressions be taken in more than two sections. Such cases may still be taken in modelling compound by using a Supplee tray and making each impression in fives sections, or, if needs be in these rare cases, plaster of Paris may be resorted to."

"The actual time spent in taking compound impressions using this technique, probably exceeds that which is necessary when plaster of Paris is used; but, even so, the matter of time is not a serious consideration as this technique may be carried out to the very letter and satisfactory impressions

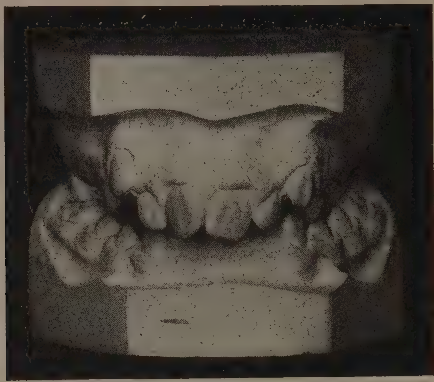


FIG. 1141.—Model of permanent teeth made from a sectional compound impression. (*Dr. James McCoy.*)

obtained of both upper and lower arches with the total amount of time spent not exceeding fifteen minutes."

Preparation of Sectional Impression for Pouring.—"In preparing an impression for pouring, it should first be thoroughly dried out either by compressed air or by allowing it to stand a sufficient length of time, so that

FIG. 1142.—Occlusal view of upper and lower casts of model shown in Fig. 1141. (*Dr. James McCoy.*)

all surface dampness is removed, and then it should be given a light coat of very thin sandarac finish. This varnishing is not done with the idea of acting as a separating medium but simply as a means of insuring a better finish to the model surface. After the varnish has become thoroughly hardened, the model is poured in the usual way, care being taken to avoid the formation of air bubbles."

Separation of Impression from Cast.—"After the plaster has become crystallized, the impression may be separated from the cast. This process should be carried out with due care and accuracy if satisfactory results are to be obtained. The poured impression is immersed in hot water, the temperature of which should be 120° F. There should be no guess work in this matter, but an accurate thermometer should be utilized. The water in the dish should then be gradually raised until it has been brought to a temperature of 130° F. After the impression has been immersed at this temperature for three minutes the impression material may be readily and easily removed."

"It is a great mistake for the assistant to attempt to carry out the separation process without the aid of a thermometer as invariably one is apt to get the water either too hot or too cold, or, what is just as inadvisable, to heat it up too rapidly. When the impression is not properly heated all the way through, teeth will be broken off when it is removed, and, on the other hand, if it is too highly heated it is apt to melt upon the cast resulting in the discoloring of the plaster."

"This method of taking compound impressions in sections undoubtedly will not appeal to some operators, but it should not be condemned until it has been given a fair trial, and such a trial entails its use under proper conditions, utilizing a technique in keeping with an exact procedure."

CHAPTER LXVI

PROPHYLAXIS

Mouth Hygiene.—During the wearing of appliances in the mouth the greater liability of food collecting around the teeth, and the lessened activity of the oral fluids in performing their natural cleansing function makes it imperative that especial prophylactic measures be instituted.

The patient's teeth should be thoroughly cleaned before the commencement of operations, and during treatment instructions should be given for the frequent use of the tooth brush, preferably after each meal and upon arising. A tooth brush with one row of bristles is much better adapted to cleansing above and below the alignment arch than the brush with several rows of bristles. The lingual arch, although more self cleansing than the labial arch, should be just as carefully brushed, and thoroughly cleaned upon each visit of the patient when it can be removed.

Frequently, the removable parts of the appliance should be removed, and the teeth cleansed carefully with pumice or washed with alcohol. It is of still greater benefit to have the patient referred back to the family dentist for more detailed prophylactic treatment, especially with the orange wood stick and pumice.

Care of Ligatures.—Silk ligatures should be frequently renewed as they readily absorb the food products and become active agents in the formation of "retention centers." If silk ligatures are saturated in campho-phenique, and kept tightly sealed in glass tube containers, they will remain free from the products of food decomposition for a much longer period.

Pneumatic Sprays.—The compressed air spray in connection with antiseptic mouth washes, is most beneficial as a prophylactic measure, being used at each visit of the patient throughout the treatment.

Dr. Ferris has recommended a combination of sprays which have certain peculiar reactions which make them of exceptional value, being both chemical and mechanical in their action.

The first of the series of sprays contains the active agent iodine in combination with potassium iodide, which acts germicidally to destroy the spores and parent cells in albuminous material, which it readily penetrates, staining the bacterial plaques so that they are visible upon tooth surfaces.

The second spray consists of a starch solution which absorbs the stained plaques, forming a flocculent precipitate, which is readily removed by the third spray which is a simple solution of sodium carbonate, having the power to decolorize the precipitate previously formed, at the same time freeing the surfaces of the teeth still further by saponifying the fats.

The antiseptic and beneficial value of these sprays, used consecutively, is not excelled by any other at present known methods of oral antisepsis.

The series of sprays are given below in the order of their use, it being necessary to have separate nozzles for each spray, which also must be used at the temperature noted in order to have the desired effect.

I. ℞—Iodini,	gr. xxx.
Potassii iodidi,	gr. xix.
Aquæ dest. ad. q. s.	℥ iv.

Sig.—To be used in spray under high pressure at the temperature of 98° F.

II. ℞—Starch,	gr. xxxviii
Aquæ menth. pip.	℥ iv.
Oleum menth. pip.	♏ xx.—M.

Sig.—To be used at the temperature of 115° F. In making this compound, mix the first two ingredients and let stand for five minutes, then boil for five minutes, then add the flavoring.

III. ℞—Sodii carb.,	gr. xxxviii.
Aquæ gaultheria,	℥ iv.
Olei gaultheria,	♏ xxx.—M.

Sig.—To be used at the temperature of 115° F.

Tonic Mouth Wash.—Ferris also recommends a tonic mouth wash to give tone to the mucous tissues, and to develop normal secretion during abnormal conditions. The formula is as follows:—

FORMULA No. IV.

℞—Hydronaphthol,	
Menthol,	āā gr. xxx.
Oil gaultheria,	
Oil cassia,	āā ♏ iv.
Alcohol,	℥ x.
Tinct. capsicum,	ℨ i
Aquæ dest.,	ad q. s. ℥ xx.

M. Sig.—Teaspoonful to half-glass hot water five times daily.

INDEX

Guide to the Index.—The index has been arranged with a view to direct the reader to his subject without delay. All readers do not think of the same subject matter in the same form, therefore the same subject will be found indexed in various forms. For instance:

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Where a — appears before a line it indicates that the indexed line relates to the sub-heading above it.